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ABSTRACT

This book explores the educational mission of teachers. Based mainly on opinion and anecdotal evidence--yet supported by some research--this book calls on teachers and parents to look beyond the old myths about what a good school is and instead focus on facilitating intellectual, ethical, and aesthetic growth in students and in themselves. The book is divided into 10 chapters organized into 3 parts. In part I, "Learning to Live a Life," chapter 1 looks at internally and externally imposed standards. Chapter 2 discusses how learners build foundations for new learning. Chapter 3 pictures classrooms that encourage students to ask questions. In part II, "Unlearning Lessons Learned in School," chapter 4 describes lessons with lots of talk but few conversations. Chapter 5 illustrates the school model of students merely showing up and following directions. Chapter 6 portrays students memorizing many facts but learning few principles. Part III, "Lessons That Last," contains four chapters. Chapter 7 explores knowledge. Chapter 8 suggests that the professional community adopt a new community-of-learners model. Chapter 9 presents examples of types of curriculum in which all students can participate successfully and productively. Chapter 10 examines constructivist education. (Contains illustrations, 9 online resources, and 83 references.) (WFA)

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Schooling for Life

RECLAIMING

THE ESSENCE

OF LEARNING

Jacqueline Grennon Brooks

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~ DEDICATION ~

To three mentors

Marty, Emily, and Alex

Schooling for Life

RECLAIMING THE ESSENCE OF LEARNING

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JGB

March 2002

Preface

I'VE WRITTEN THIS BOOK BACKWARDS. I DIDN'T START AT THE beginning because I couldn't find it. A dear friend, Vivian Doremus, and my wonderful husband, Martin Brooks, volunteered to be critical readers, and with each draft, they responded that they followed the writing, but that there was no good beginning. Perhaps that's a metaphor for the education we all experience as we live our lives. Each of us is thrust into a world that is already in full swing. Our task is to make ourselves into who we want to be while simultaneously fitting ourselves into the world we are constantly constructing. It's not easy being human.

I eventually found the beginning of this book in the beginning of my own life, recalling memories of myself as a child trying to make sense of a world full of contrasts and confusions. As a youngster, I experienced school as a place to put in time. There were so many things I wanted to know . . . but there were so very few occasions in school to learn them. There were so many explorations to begin, wonders to analyze, discrepancies to resolve. . . but it seemed that school was not the place to do this.

Today, as an educator, my primary mission is to make school a place in which my students do not simply "put in time" but one where they invest time and effort in solving problems they see as relevant—problems they want to solve. Living and learning and teaching occur everywhere. This book is about how we might, in the name of progress, blur the distinctions between "school life" and "real life," between learning and teaching, between learning well and living well.

There are many complications that make our educational mission difficult. Today's focus on accountability takes many teachers away from learning issues. So does the spotlight on test results and the corollary judging and ranking of schools and students. So does the omnipresent quest for all students to meet all standards. This book is a call for action and a rallying cry toward the center of our educational mission. I believe that we—teachers, parents, guardians of rising generations—*can* have the schools we really want if we are bold enough to look beyond the old myths about what a good school is and, instead, focus on facilitating intellectual, ethical, and aesthetic growth in our students and ourselves.

What matters most in education is the process of answering old questions and asking new ones. We exhibit and learn and teach values in every question we ask and in every question we answer. The voices and viewpoints I present in this book belong to teachers, parents, and students who are trying to reach the heart of school matters—and of what matters in school. All the people in this book are real. I have changed names and, at times, a detail or two to preserve privacy, but all the stories are true.

I invite you to join our journey focused on making sense of what we do in school and the reasons why we do them, what we don't do in school and the reasons why not, and what we can do in school and the reasons why they are necessary. It's my hope this book will provoke conversation by bringing to the forefront thoughts that will help us ask and answer these questions.

PART I

Learning to Live a Life

LIVING A LIFE IS A FUNCTION OF THE PERSONAL standards we set for our own behavior, the questions we ask as we seek to learn more about our world, and the paths we select as we search for meaning. Our definition of a good life routinely changes as the years go by, but the processes by which we seek, create, and maintain the order necessary for that good life remain essentially constant. Part I of this book illustrates some of these processes, in real life and in real schools. Chapter 1 journeys through childhood memories and professional experiences relating to internally and externally imposed standards. Chapter 2 discusses perspectives on issues critical to understanding how learners form new concepts and, thus, build the foundations for new learning. Chapter 3 depicts classrooms that foster student questions and encourage students to seek answers. Each chapter presents the case that the quest to understand the relationship between life's details and the "big ideas" that shed light on them is the hallmark of meaningful learning.

A Life with Standards

"IS THIS GOOD?" "AM I DONE?" THESE QUESTIONS ARE ASKED out loud, in various formats, in homes, schools, and workplaces everywhere, with the notion that it is someone else—a parent, a teacher, or a supervisor—who has the answers. These are good questions to ask. They reflect the questioner's desire for feedback, willingness to collaborate, and readiness toward meeting goals. They also reflect the questioner's valuing of codes of practice, or criteria for success, or canons established by competent authorities—what we often refer to as standards.

But these questions are also self-limiting. A direct answer typically has little utility past the moment of the answer. The most influential parents, teachers, and supervisors are the ones who know how to help those who seek guidance *set their own standards*, or, at least, adopt, agree with, or see the merit in a published set of standards. Within this context, determining what is good and when a task is finished are processes negotiated between the novice and the expert.

We all pose internal questions about our worth, progress, and achievements as we embark on new journeys, engage in new study, and venture into new research. When people in our lives skillfully help us revisit such questions as they relate to the specific task or challenge at hand, we spiral through what we already know, what we have just learned, and what we still must conquer. Each time those mentors help us question ourselves, they remind us of what we seek and inspire us to revise and raise our standards. Inherent in this interaction is an appreciation of the human capacity for ongoing learning—our

ability to identify problems, ask questions, and find solutions. How do those capacities emerge? How do the internal standards that guide our outlook and our actions come to be?

Learning to Find and Solve Problems

Does learning to find and solve problems provoke the construction of internal standards? I think they do. Getzels and Csikszentmihalyi (1976) suggest that formulating problems is an essential element in understanding creativity—more so than solving problems. Arlin (1990) suggests that the same is true in understanding wisdom: problem finding is more significant than problem solving. Csikszentmihalyi and Sawyer (1996) study the acts of problem finding and problem solving in relationship to insight. I contend that meaningful internal standards emerge from these finding and solving processes, and I offer the following stories from my own history as one characterization of what it has meant to one group of people to find problems and to solve them—one way or another. As you read, consider: Do the standards that I see emanating from these finding-and-solving processes meet the standards you hold?

Girls in White Dresses

When I was in junior high school, my world history teacher told my class a story of a philanthropist who supported Christian missionary work around the globe. Each year, the philanthropist donated an exquisite white communion dress, with tulle, lace, and beading, worth thousands of dollars, with the directive that it go to one lucky little 7-year-old girl in an impoverished village. My teacher marveled at the philanthropist's generosity and at the excitement and splendor that the young girl chosen to receive the dress must have felt. As a 13-year-old, I followed my teacher's lead. I, too, thought that

the rich philanthropist made a fine gesture by providing such a luxurious gift to someone with so few extravagances.



I went home and shared the story with my mother. Her first reaction was, "What about all the other little girls?" She argued that bestowing such frills on one child and having all the other children feel like losers in the dress lottery was a poor use of resources. The philanthropist would do better, my mother said, to use those thousands of dollars to buy yards of plain fabric, loose beads, sewing machines, scissors, and thread. That way, every girl in the village would have the chance to make her own unique white dress and apply the lessons learned about planning, measuring, cutting, and sewing in the future. My 13-year-old self sighed, "That's Mum, always finding a problem and missing the point."

That was many years ago. Today, I see my mother's solution as inclusive, and generative of a sense of community—and an equitable use of resources. I apply the lessons of the girls in white dresses in my life as an educator.

I ask myself the following questions:

- Do I present a challenge, bring resources to the table, and ask students to address the challenge? Or do I define the problem and design the solution for them?
- Do I support their efforts to make important decisions that will guide how hard they will work and toward what end? Or do I make the important decisions and expect appreciation for doing such?
- Am I fashioning learning environments that foster co-investigation, independence, and interdependence? Or do I create environments that cultivate jealousy, protectiveness, and dominance?
- Am I creating a community of learners? Or am I creating a competition, with winners and losers?
- Am I using the resources around me in ways that are respectful of all the learners and the environment? Or do I use resources that prompt calls of unfairness and favoritism?

My answers to these questions are contextual. There have been times when I was trying to distribute resources fairly and found out I wasn't . . . times when I thought I was guiding learners to cut their own pathways only to find I was leading them down the road I wanted to take. My internal standards help me adjust my practice. They compel me to help learners articulate the nature and scope of the problem themselves, and they help me to see when I'm missing the mark. Imposing my own perspective may funnel learners' thinking to mimic my words, but it does little to help learners generate solutions from their own experimentation and understanding. Through discourse with peers and mentors, I use my current standards to guide my practice. Other times, I develop new standards and proceed accordingly.

Potholders in the Eye of the Beholder

As children, my sisters and I created potholders out of the cords of yarn we spun on a little red spinning wheel my father gave us. We carefully followed the directions that came in the box and we made potholder after potholder. To my mother's eyes, they were something more. She decided that if we omitted the handle, our

"potholders" could just as easily be lovely "chapel caps"—little head coverings suitable for a respectful visit to church.

My mother was an unconventional woman, seldom bound by protocol, and always looking for life's "big ideas"—the important things, the basic things, the essences. A hat, she reasoned, is something we wear to cover our crowns. Beyond that, it is all detail. According to my mother, whether lace, fur, pill-box, or potholder, when worn on the head, they were all hats. My sisters and I looked in the mirror my mother held—and saw only potholders.

Nonetheless, we created handle-less potholders in colors that matched the wool of our winter coats, and off to church we went in our lovely chapel caps. One of my friends pulled me aside, concerned. "Why are you wearing a potholder on your head?" she asked. "It's not a potholder," I replied, somewhat more confidently than I felt. "It's a chapel cap." "No," my friend insisted. "It's a *potholder*." It wasn't always easy being the child of such an inventive mother.

Likewise, it's not always easy being the student of an inventive teacher. Such teachers usually hold a mirror up to each student, asking them to look beyond the obvious and see the possible. For these individuals, the "big idea" of teaching is to take their students on intellectual journeys to unexplored places. This is their objective, their purpose; all else is detail. Much as my mother saw something that covered our heads as an appropriate chapel cap, inventive teachers see a trip to the hardware store, or an ad in the Sunday paper, or a new product in the supermarket, or the morning weather as an *instructional opportunity* to jump start a new journey. With this vision to guide them, they figure out the particulars anew with each class. Choosing the right mirror and deciding how to hold it, cutting the pathways for the journeys, and knowing when to turn back—these are the many small decisions that reveal these teachers' quests for the big ideas. My mother had very stringent standards. It happened that her standards were quite different from the norm, but they were rigorous nonetheless. It's imperative that teachers have the autonomy to develop these internal standards, meet them with conviction, and encourage their students to do the same.

Stolen Garbage

As you might imagine, my mother's own quests for the big ideas that would guide our lives led to many unique systems in our household. She designed one such system after concluding that setting out garbage in regular garbage cans just resulted in the sanitation workers expending unnecessary energy to empty the cans into their truck and us expending unnecessary energy to retrieve the cans after pickup. So she devised an alternative system. Wet garbage we wrapped in reused plastic produce bags. Around this core we packed the dry garbage, including empty cans, washed and flattened to save space. We loaded it all into reused brown paper bags, which we folded in 90- and 45-degree angles, and then sealed with one strip of masking tape. These neatly secured packages looked like they might have fallen off a UPS truck. Our garbage routinely disappeared before the sanitation workers could get to it the next morning!

As a child, I found these operations time-consuming and quite a nuisance. It was an effort to make certain that the sanitation workers didn't hurt themselves on the edges of rough cans and that they weren't exposed to health risks from rotting refuse. It was an effort to minimize waste. It was an effort to care about people we never actually saw. (The sanitation workers arrived at our house before dawn.) That was then.

Today, as an educator, I ask myself these questions:

- Am I helping students recognize that social responsibility is a lot of trouble, requiring good, necessary effort?
- Am I creating learning environments based on every student having a role in the classroom dynamic; do I help make the "invisible students" visible?
- Do I honor the skills of each member of the classroom community without hierarchy and without judgment?
- Do I create a classroom culture in which every student is valuable and in which every student has the chance to appreciate how much worthy effort it takes to maintain an integrated, safe environment?

Corrugated Cartons and Flat Cans

The desk my mother made from a corrugated cardboard carton still stands at my parents' house. Do you think a woman who scoffed at garbage cans and designed a low-energy, volume-efficient waste management system would go out and buy ready-made furniture? New furniture that was apt to be expensive and never the right size? Our family needed pieces custom-made for the available space. Enter the corrugated cartons the movers had used to transport our belongings to our new house. My mother showed us how new desks, vanities, and bureaus could all be ours with a serrated knife, masking tape, and carefully applied contact paper.

You can't work with corrugated cardboard so intimately without learning something about the structural strength of triangles. Those triangular corrugations between the layers of flat cardboard aren't there for decoration! Whoever designed the first corrugated cardboard synthesized some important ideas about physics, forces, stress, tension, compression, weight distribution, economies of scale—the list could go on.

Just as building cardboard furniture can turn into an investigation about triangulation, crushing cans throughout childhood can set the stage for scientific inquiry and experimentation. Can-flattening, part of my mother's sanitary and space-and-energy-efficient waste disposal system, was well established in our household long before that first compactor found its way into "modern" kitchens and long before that first recycling container found its way to the curb. It didn't take us long to discover that if you stepped down slowly on the side of a can, you could get a ride before the metal caved in. Questions followed: Is the ride the same for soup cans as it is for the big cans that hold whole tomatoes? Everyone in our family knew that the tomato cans gave a better ride. Could the can's diameter have anything to do with this? Or might it be that the bigger cans were made of thicker metal?

Experiences with everyday objects, in either a formal educational setting or in the casual home life activities discussed here, and the accompanying reflection on those experiences together provide the intellectual scaffolding necessary for foundational learning. Experiences of this nature, or with

people or ideas, combined with the process of abstracting those experiences into hunches, rules, laws, or patterns, form the foundation of important learning—the basics from which more sophisticated concepts or theories emerge. In these home life examples, the tradition of solving a problem the best you can with the resources you have at hand, although modeled by the adult, puts the responsibility of learning with the child.

Squeezing Life Back into School

How can these stories of simple home life activities inform the complex processes of formal schooling? There's much to learn from the acts of putting out garbage, making furniture, or giving money to charities. And there's much to connect to later in life when can-flattening, furniture-making, dress-sewing children take physics classes that explore inertia, torque, and collisions, or take economics classes that explore social policies, or take ecology classes that explore cycles and systems.

We must consider many elements when we design the environments in which our children will grow, develop, and learn about life. It is possible to design formal school settings in which learners of all ages can grow and develop while thinking deeply about important issues. It is possible to design formal school settings in which the adults who teach these important issues still think deeply about them themselves. These settings form the real basics of ethical, intellectual life. Our problem is that we too frequently eliminate real life from school.

If we put meaningful learning, with all of its amorphous qualities and unique paths, back into the hands of the teachers and the students, we can generate the type of positive engagement in tackling problems and generating solutions that takes place when learners of any age try to make sense of anything from old cans and boxes to economic policies, Elizabethan poetry, algebraic functions, or any of the typical ideas studied in school. Standards generated and judged from within are more useful standards. When we create schools that honor the processes of constructing and judging standards from

within and endeavor to enhance those processes, we will then have schools with high standards.

Common Thinking

Common thinking is that teaching is simple. But teaching isn't simple. It's a highly sophisticated intellectual activity that requires, among other things, a centered presence in a classroom, good negotiation skills, understandings of pedagogy and psychology that inform one another, and sensitivity to sociological factors in learning. These skills must accompany a good deal of content knowledge in at least one discipline, and often a number of disciplines.

It's also common thinking that learning is simple. But that's not true, either. Learning requires an active mind. It requires a question that rouses intrigue, or a piece of information that doesn't seem to fit, or a novel that transports the reader to places previously unknown, or a math equation that challenges the learner's suppositions about numerical relationships, or any prompt that provokes some dissonance in the learner. Learning also requires a teacher who has the skills and insight it takes to drive students' thinking processes forward. The intriguing question, information, novel, or equation is part of the teacher's repertoire of instructional practices designed to spur interest, generate knowledge, and develop competency. Learning isn't simple. But when sought and pursued actively and mindfully, it is energizing, dynamic, and cherished. When learning is not sought, but pursued passively and perfunctorily, it is most often shallow, incomplete, and short-lived.

Common thinking also posits that both teaching and learning can be legislated and controlled through state testing and accountability programs. They can't. To think that they can trivializes the intricate demands and accomplishments of classroom life. The significant meanings of teaching and learning transcend the published charts that compare test scores

among school districts and the headlines that applaud the virtues of districts with higher scores. Test scores as a measure of real learning may enable state officials to construct lists of schools in need of improvement, but the establishment of those lists does precious little to generate real, meaningful improvement. Thinking of testing and accountability programs as ways to require teachers to do a better job and students to learn more is political thinking, not educational thinking.

In the United States, these tests and the accountability systems that accompany them are rooted in the standards movement, the current push to realign, readjust, and reassess curriculum and testing so as to match standards created by state-sponsored committees. Most states throughout the nation have published these standards during the past decade, and they have charged school districts with the task of creating action plans. The various states' standards and the accompanying action plans are widely viewed as benchmarks for all students . . . or, more accurately, for the schools those students attend. The standards, if reached, are thought to guarantee a higher level of achievement for students. And even if these standards are not reached, they're thought to ensure a more rigorous educational journey.

To many people, this plan seems to make good sense: Set the high standards, align instruction to the new standards, test students to determine if they are reaching the new standards, and publicly identify which schools are "succeeding" and which are not.

Standardized to a Fault

If this strategy is as logical as it seems, why are educational standards coming under increasing criticism (Kohn, 2000; Ohanian, 1999; Popham, 1999)? I think it's for the same reason that we debate water quality standards, compare automobile safety records, monitor Food and Drug Administration policies, and scrutinize political campaign finances. The variables are coming into focus, and we're realizing that the issues aren't simple.

Let's look at water quality standards as an example. The quality of the water we drink is controlled by stringent standards, and most of us not only tolerate those standards, but also demand that they be present and as high as possible. As a society, we have determined that access to pure, clean water is fundamental to good health and productivity. As a result, few quarrel with the process of measuring the levels of foreign substances in the water supply. But there is debate over the more complex issues related to setting and enforcing those standards. What level of foreign substances can be present in our water before we declare it unsafe for consumption? How much does every fraction of a point on the purity scale cost in dollars? Should we add purportedly healthful substances to the water supply? Who stands to gain or lose when substances are intentionally added?

When analyzing water, we also need to know the sample's origins and the conditions under which it was drawn. When the results show impurity, we must determine the cause of contamination: is it the water source, the pipes, the faucet, or something else? Only when we know more about the concerns of the scientists and citizens and the research used to determine the standard can we begin to spotlight the variables in the formula. Then we must consider the skills of the technicians and the conditions under which they gathered the samples. At this point, the complexity of the initially simple water-quality issue begins to come into focus.

"A Good Education"

Just as water quality standards bring multiple variables into play, so do educational standards. Standardized testing in education is coming under criticism by those who have been studying these related variables. The conclusion of these studies, simply put, is that the testing of learning is interfering with learning itself. How can that be?

To understand how testing can subvert a good education, we must first define what a good education is. It is a system of opportunities for students through which they build the foundational skills of an intellectual, ethical, aesthetic, and physically

fit life that they can both use in the present day as student citizens and develop and transfer to their future as global citizens. The conflict is that a setting suitable to guide students in this immense task is very different from a setting suitable to prepare students to pass a particular test given on a Tuesday in June or a Thursday in March. Why would the program a teacher offers to help students develop transferable skills be so different from a program designed to prepare students to demonstrate those skills on a particular exam? Because learning is inherently interdisciplinary and multivariate. Its largeness and connectedness generally elude measurement by standardized tests. But the essence of standardized test criticism is not merely that these tests fail to capture certain successes; it's that the existence of those tests—and the fact that the data they generate are applied in the pursuit of accountability—change the very nature of the classroom experience.

I am reminded of the uncertainty principle, a principle within the field of physics, developed by Werner Heisenberg. The uncertainty principle states that the more precisely we can determine the position of a very small particle, the less precisely we can determine the momentum of that particle. Conversely, the more precisely we can determine the particle's momentum, the less precisely we can determine its position. Although there is always a danger of fostering misconceptions when you apply principles from one domain (in this case, particle physics) to another (education), the possibility for insight also exists. Wassermann (2001) evokes the works of Feynman, Einstein, and Heisenberg in making her point that "We talk about students' test scores with the arrogance of the self-assured; we are certain when we should, at the very least, be suspending judgment" (p. 35). Let's look at an educational example through this lens.

The "good" educational environment just described depends on a degree of intellectual autonomy usually not available to teachers and students in schools designed to produce high scores on state tests. In other words, the pursuit of high test scores creates schools that look like factories; the pursuit of answers to amorphous, complex problems creates schools that look more like think tanks. Trying to precisely determine

a student's exact intellectual position in the think tank decreases our ability to determine that student's intellectual momentum—a measure that more significantly informs the teaching process. And precisely determining the student's intellectual momentum decreases the accuracy with which we can determine the student's exact intellectual position (the measure characteristically published in newspapers to rank the worth of the student's school). Schools are complex systems. Trying to make them look simple just doesn't work. Wishing they were simple hasn't worked yet, either.

Changing Images of Complex Systems

Suppose we could free the standards movement from the standardized testing movement. Could the inventive teachers we have discussed—those teachers who view their students as unique constructors of their own knowledge—then find guidance and professional growth in the learning standards?

To provide the type of education in which learners learn the dispositions, skills, and interdisciplinary concepts that transfer to new settings, teachers must understand the standards of their subject matter disciplines and use these standards as the foundation of their instruction. We expect the same for members of other professions—say, chefs, journalists, attorneys, musicians, accountants—whose creations, publications, performances, or practices grow out of the standards accepted in their disciplines. Standards form the basis of how the professionals in a field operate. They become the lenses through which professionals exercise judgment.

A problem emerges, however, when standards cease to be guideposts for professional creativity and practice and instead become hurdles through which professionals must jump, or dictated levels of performance, or a fixed sequence to follow. When this occurs, as it too frequently does, the positive power of the standards begins to deteriorate. Why? When professionals use a

set of standards as guideposts, they also use contextual clues to decide their professional courses. When an educator becomes merely an implementer of a pre-established routine that excludes reasoning and judgment, the educator is no longer an educator.

The following example describes how a good teacher looks to internal professional standards to guide practice, rather than to external, imposed standards. I have chosen a music teacher to illustrate the complex system of standards-based teaching, even though music education is not usually a standards-judged area. Still, music is an outcomes-based subject area in most schools. Public performance is a staple activity within the music community and I suggest there is a powerful, although perhaps not well articulated, standard by which the audience member in all of us judges excellence.

Mr. Palmer teaches instrumental music. I visited his class on a day that he was helping a young trombone player named Henry conquer a difficult segment of a new piece. In analyzing his student's performance and suggesting instructional pathways to pursue, Mr. Palmer commented, "We're not playing notes anymore. We're making music."

An experienced professional like Mr. Palmer is able to break an analysis of Henry's performance into two parts: Henry's errors—whether or not the notes he plays match the notes written in the piece—and Henry's interpretation—what mood or tenor his version of the piece evokes. This combined technical and interpretive analysis of a performance, which involves giving students feedback regarding their pursuit of musical excellence, is the standard by which Mr. Palmer teaches.

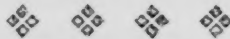
Mr. Palmer's aim is to bring Henry to the highest level of performance with regard to the music being played. One foundation of this approach is to help Henry conquer difficult segments by showing him how to look at music as packages made up of parts. Henry doesn't have to count the parts anymore because Mr. Palmer has helped him to look at the packages: no longer individual notes, but *music*.

Next, Henry's interpretation of the musical piece becomes the point of discussion and focus. Packaging, pauses, and passion become variables that influence this interpretation. They

become variables that influence what the teacher highlights or stresses. Mr. Palmer could not possibly help his trombone player look at music and the instrument in ever more sophisticated ways without relying on the wealth of his own musical experience. He searches for patterns in the musical pieces he offers his students to play and he invites his students to see those patterns. He also asks his students to discern patterns of their own. With every new piece of music, Mr. Palmer must bring to his teaching his whole understanding of music, then interface that understanding with his analysis of appropriate next steps for his students.

As Mr. Palmer's students mature, they become physically able to play more sophisticated pieces. Arms grow, finger-span increases, facial musculature defines, lung capacity develops. At the same time, the students' increasing experience with the music and their instruments and their advancing social maturity to sustain longer periods of playing and practice also contribute to their progress as musicians. Teacher and students begin to communicate with a new vocabulary, with the teacher's professional judgment at the core of the vocabulary, processes, and perspectives being offered. The students control what is learned, while the teacher controls the opportunities in the learning environment.

When we consider the sophistication of this process—guided as it is by evolving internal standards, evolving contextual information, and evolving learners—giving Mr. Palmer a published set of music standards and using a sequenced checklist to supervise his coverage of those standards seems not just unnecessary, but downright silly.





A Life with Questions

GOOD QUESTIONS HAVE ALWAYS BEEN IMPORTANT. GALILEO watched the chandeliers swing after they were cleaned and asked if the patterns he saw could be useful in making an instrument to measure time. Martin Luther King Jr. looked at segregation and prejudice and asked how he could contribute to righting that wrong. Georges Seurat looked at the Impressionist paintings of colors applied in small strokes and wondered what would happen if he reduced the strokes of color to dots of color. Rosalind Franklin looked at her crystallography plates and asked if the patterns she saw were proof of the helical structure of DNA. Good questions have been key to human civilization's greatest achievements. They generate new information, which we use to create new knowledge.

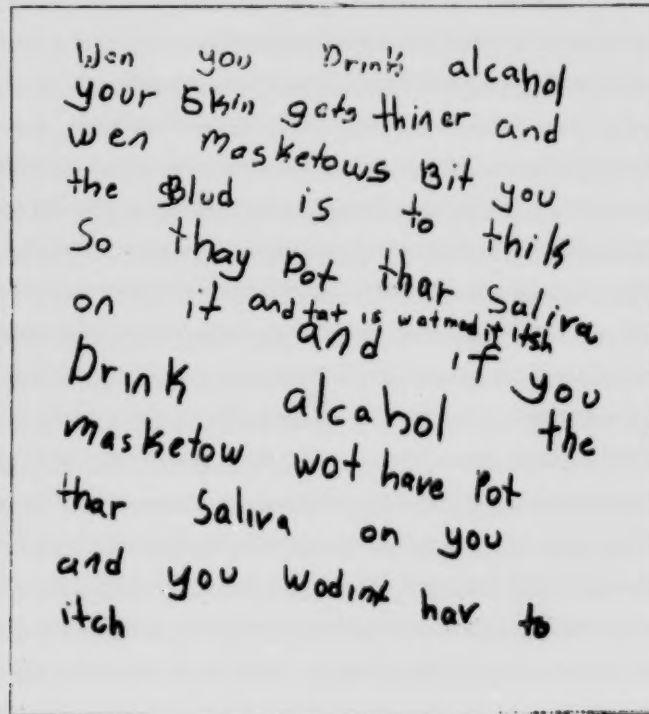
In this context, consider the question posed by Emma, a 2nd grader. So far, it hasn't changed civilization. In fact, she hasn't even gotten an answer yet. One day, out of the blue, Emma commented to her teacher, "I wonder, if you drink alcohol before you go out at night, would the mosquito bites still itch?"

The teacher found Emma's musings rather perplexing and asked Emma to explain how she came up with her question. So she did:

The lady from the museum told us that our blood is too thick for mosquitoes, so they put their saliva on us to make the blood thinner, and it is the saliva that makes us itch. Then I remembered from health class that alcohol makes your blood thinner. So I was just wondering:

If your blood was already thin, maybe the mosquito wouldn't have to put the saliva on you and then you wouldn't itch.

Emma's teacher thought the proposition was too intriguing to lose and asked Emma to write it down. Emma's work is reproduced here.



Next, Emma read her story back to her teacher:

When you drink alcohol, your skin—oh! I meant to write “blood”—when you drink alcohol, your blood gets thinner, and when mosquitoes bite you, the blood is too thick. So they put their saliva on it and that is what makes it itch. And if you drink alcohol, the mosquito won't have to put their saliva on you and you wouldn't have to itch.

Emma's story, full of unconventional spelling, word substitutions, and deletions, teaches us a great deal about how to be a teacher. It reminds us not to be fooled by appearances and

not to be hasty in judgment. Although her story may look like the work of a younger child in its form, it exhibits a line of reasoning more typical of a child older than she. Emma used what she knew about alcohol and insects (based on information she encountered in different lessons, given by different teachers, months apart) to question something she didn't know. This is the kind of questioning we must encourage in our students. Our civilization depends on Emma—and other children like her—growing up without losing the capacity to question and explore further what they know and what they don't know.

Really Knowing

Knowledge depends on questions, and the process of coming to “really know” something entails revisiting the essential concept in new settings, under new conditions, and with new parameters often enough to challenge one's own thinking. Both teachers and students need these opportunities to question content knowledge and challenge the accuracy of what is supposed to be true. It's only when we acknowledge that there are things we don't know, that we are ready to learn.

Unfortunately, in most school settings, to acknowledge that we don't know something is a sign of failure rather than a starting point for learning. So, as students, and as teachers, we hide what we don't know, sometimes through elaborate schemes. And although many of us still attain academic and professional success, our intellectual development suffers the consequences. We cannot make progress as learners if we don't understand where we are now and why where we are now is no longer satisfactory. To really know something is to understand our boundaries, then search for ways to extend them. How does this scenario play out in a classroom?

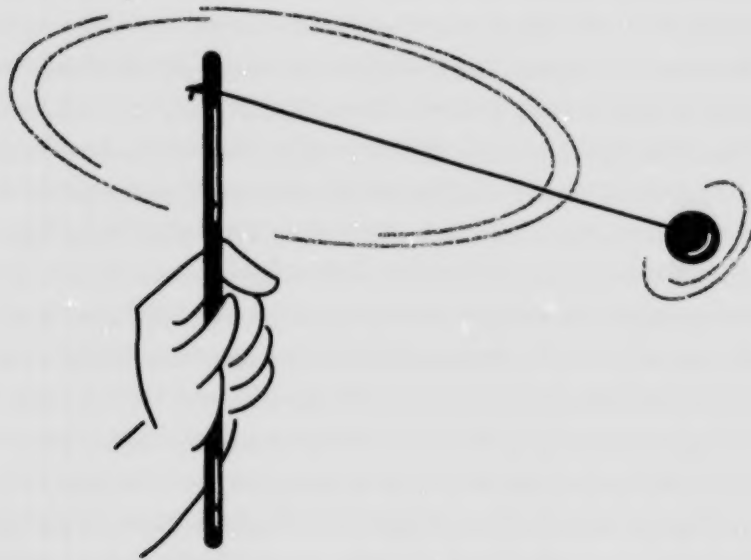
Assessing Current Understanding

At some point, all of us have looked into the night sky and gazed at the face of the moon. Long ago, astronomers determined that we always see the same side of the moon, regardless of our location on Earth, the season, or the time. Why is this so?

Ms. Stanford is a high school science teacher who has explored the understanding—or misunderstanding—of this phenomenon with both adults and adolescents. Let's look at how one class of 9th graders approached this question, paying particular attention to the intellectual prompts this teacher used to direct her students' exploration.

The first explanation Mrs. Stanford's class generated in response to her question was that maybe we always see the same side of the moon because the moon doesn't rotate; it revolves around Earth, but doesn't spin on its own axis. Ms. Stanford knew that the moon does, indeed, spin on its own axis. Furthermore, she intended to aim the lesson toward the rate of the moon's rotation in comparison to the rate of its revolution. But despite her knowledge and ultimate objective, she responded with a follow-up question targeted to her students' current understanding (the starting point for any investigation): Is it physically possible for a celestial body to revolve if it does not rotate?

An investigation of this type might proceed in a number of ways. Many published curricula suggest teachers demonstrate celestial revolution with a ball-and-string model. The ball is marked with orientation symbols and connected to a stick with a length of string. The teacher holds on to the stick, spins the ball in orbit-like circles, and varies the length of the string as she directs the students to see what happens to the rates of the "moon's" revolution and rotation as the string gets shorter. In these curricula, there is often a tacit message to the teacher that a series of such demonstrations will result in students' learning the right answer: As the string-length shortens (representing the diameter of the orbit decreasing), the speed of the ball increases (representing the speed of the moon increasing).



Watching the ball-and-string model might help some students understand why we always see the same side of the moon. But for other students, trial after trial with the model might never help them generate an explanation that satisfies them. In fact, many students who use this model do not see the ball as rotating.

In her earlier teaching days, Ms. Stanford would use this model, draw the correct conclusion for students, and then ask if they understood. The students would nod their heads, and Ms. Stanford would enjoy the false positive that in this lesson on celestial revolution, the students also understood that the "moon" was rotating as it revolved. In all probability, many of those former students didn't understand. Today, Ms. Stanford integrates teaching and ongoing assessment as complementary processes and uses very different strategies because she has learned that not only *some* but *most* students do not see the ball in the ball-and-string model as rotating.

Working With Evolving Knowledge

Ms. Stanford has collected a number of ball-and-string models that her students can use to explore the Earth/moon orbital

relationship. She also makes available cones with marbles and balls of various sizes. After students have experimented with self-chosen models, and analyzed and discussed their findings, she frequently shifts instructional gears and brings out yet another model—not only to help the students who don't "get it," but also to help the ones who do. Perhaps the string portion of the model was a detractor for some students. If so, using objects not physically attached may be useful. For other students, the ball attached to the string may have conjured up a mental image in the students' minds that links nonsalient variables to the phenomenon.

To assess students' evolving grasp of the concepts, Ms. Stanford looks carefully at students' demonstrations using the new materials, noting their use of experimental controls, their record-keeping strategies, the nature of their predictions, their ability to distinguish observation from inference, and their implementation of many other processing skills central to learning for understanding and for competency. Students and teachers need mediation, information, and support while the "need to know" exists. In a class setting, when some students start sharing their "aha's," the need to know increases in the other students. They want to know what it is the others see that they don't.

Students in Ms. Stanford's classes often try to help each other out. For example, in the class of 9th graders I observed, a boy named Troy maintained that in all the demonstrations he had seen, the balls were revolving, but not rotating. When Troy conducted his own demonstration, his classmate, Ilca, noticed that he was rotating his "moon" very quickly.

"You need to slow down the moon," Ilca advised, taking the "moon" out of Troy's hands and rotating it slowly as she revolved it slowly around his "Earth."

It was now Troy's turn to "aha." Ilca's statement about the rate of the rotation provided the perspective he needed to build a satisfactory explanation of why we see the same side of the moon. For Troy, the key was realizing that the length of time it took for the moon to rotate on its axis was equal to the length of time it took for the moon to revolve around Earth. He then remembered a model that a previous teacher had used

with him: "It's sort of like two boxers in a ring. They dance around the floor, but always face each other."

Troy shared that teacher's explanation, saying, "I never understood what he was trying to say until now."

Cathy interjected, "The moon 'boxer' always faces Earth, but the Earth 'boxer' turns around."

"You're right," Troy said. "The Earth 'boxer' sometimes turns his back, but the moon 'boxer' never does. The moon 'boxer' is a better boxer!"

Nearby students laughed. Others wanted to know what was so funny. Ms. Stanford pulled the whole class together and asked Troy and Cathy to share the "boxer" story.

What did we see happen in Ms. Stanford's class? We saw that by spiraling around one concept for an extended period, teachers can provide students with the type of learning environment that allows them to build foundations they can use elsewhere. Ms. Stanford not only gave her students the chance to entertain multiple models to help them understand a central tenet, she encouraged them to do so.

Respecting Errors Along the Way

Both students and teachers need to understand the process of concept formation and respect the role of error in learning. Another trip back to Ms. Stanford's class can show us how students' evolving—and sometimes, erroneous—understandings can influence their learning.

Kim, a student who had been listening only peripherally to her classmates' hypotheses about why we always see the same side of the moon, suddenly yelled out, "I've got it! We always see the moon's 'bottom'! It rotates with its axis pointing to Earth."

The room quieted for a few moments as the students considered Kim's exuberant explanation. "Well," Troy reasoned, "that does explain why we see only one side."

Janie asked, "Is that possible? Can the rotation be perpendicular?"

Harry liked the perpendicular rotation explanation better than the one he was working on. At this point, it occurred to

Ms. Stanford that the lesson might soon deteriorate into an astronomer's nightmare. Would the class leave with greater misconceptions than those they began with? But what Ms. Stanford thought might be a nightmare turned out to be a teacher's dream. Kim's "hunch" about what was going on afforded the whole class an important conceptual opportunity; it prompted an exploration of the concept of rotational direction both for the class and for Ms. Stanford herself.

Ms. Stanford, due to the limits of her own understanding of rotation/revolution phenomena, had deemed Kim's explanation implausible. It was impossible, Ms. Stanford thought, for the moon's rotation to be perpendicular to the path of its revolution. But rather than announce her own understanding as "the answer," she challenged the students to roll a nearby basketball so that it spun in one direction (toward the classroom windows), while rolling in the perpendicular direction (toward the back of the classroom). She assumed it couldn't be done. The class gathered around the basketball. Volunteers starting spinning it and were delighted to see that they could get the ball to simultaneously spin in one direction while rolling in a perpendicular one.

Ms. Stanford was in quiet shock for a moment, but then she took her turn with an "aha." "Of course," she thought. "Bodies can have more than one axis of rotation!" Kim's explanation, although inaccurate with regard to the Earth and its moon, could be and indeed *is* accurate for other planet/satellite systems.

The class proceeded to investigate Kim's hypothesis and they eventually disproved it through observation of the moon's surface. The craters we see in one quadrant, for example, are always in that quadrant; they don't rotate, as they would have to if Kim's hypothesis were true. But Kim's theory led the class to look at slow-motion films and time-lapse photography of orbiting planets, spinning baseballs, and somersaulting gymnasts in order to find other examples of multiple axes of rotation. The class discovered that although the moon does not rotate with its axis pointing to Earth, the planet Uranus rotates *almost* that way (on a 97-degree axis) with respect to the sun.

Basic Luxuries . . . or Luxurious Basics?

As this look into Ms. Stanford's class suggests, she devoted a considerable amount of class time to the study of the Earth/moon question and its related investigations. Is this kind of teaching for understanding a "luxury"—something we can afford to indulge in only after we have covered "the basics"? To answer this question, we need to clarify a definition of "basic." Teachers and students must continually analyze the correspondence among what is being taught, what is being learned, and what is deemed basic.

For example, as Ms. Stanford and her students studied the moon's orbit around Earth, they were also learning other concepts *explicitly* and many academic and social processes *implicitly*:

- They were learning to consult multiple references when addressing problems, to honor other people's contentions even when those contentions are foreign to their own, and to join collaboratively with peers in the search for understanding. These processes are basic to research of all types.

- They were learning some of the physics of angular momentum and concepts about forces that are applicable to topics other than orbiting planets. These concepts are basic to science.

- They were learning how to ask for what they need, how to document their progress, and how to share their findings. These processes are basic to communication.

The time Ms. Stanford spent on this lesson was not a luxury. It was part of her students' basic education.

Conflict Resolution Versus Conflict Suppression

Ms. Stanford is adept at addressing conflict. In her class, there were conflicting hypotheses about why we see the same side of the moon. Rather than suppress the conflict, she saw the

potential learning opportunities in highlighting it and working to resolve it. More learning took place because she decided to take the time to resolve the conflict than would have occurred if she had simply said to Kim, "No, the moon doesn't rotate with its axis pointing to Earth."

When we suppress conflict in the classroom, it tends to reveal itself later. A good example of this is the well-known study in which 23 out of 25 Harvard University graduates and faculty erroneously attribute seasonal differences to Earth being closer to the sun in the summer (see Coyle et al. 2001). Students often interpret textbooks' perspective drawings of celestial orbits as orbits that are highly elliptical. Yet in class, they hear lectures stating that Earth's orbit is nearly circular. Teachers typically neglect to ask for students' interpretations of the text they are reading. Nor do they ask students to state apparent contradictions. Most teachers, on hearing that 23 out of 25 students believe summer heat is due to Earth's proximity to the sun, would likely pose the question, "If summer is hotter in the Northern Hemisphere because Earth is closer to the sun, how do you explain why hot summers in the Southern Hemisphere take place six months later?" The ensuing discussion has the possibility to highlight contradictions for the purpose of resolving them. But when the students' points of view are not elicited for the purpose of revealing conflict, important learning opportunities are lost, even though test results can create an image that learning has occurred. What we suppress surfaces again in its same form; what we resolve transforms itself into new learning.

Safe and Sound

Creating safe and self-disciplined learning environments is a major concern in today's climate. I have found that teachers and students feel safe and act self-disciplined when they feel they have the personal power that comes from questions and answers that are authentic and contextual rather than legislated

or obligatory. When teachers and students are involved in answering questions that they pose themselves—either through their own initiative or with prompting—their mental and physical energies are directed into purposeful action. It's when people are involved in exercises that seem arbitrary and meaningless that those in authority have to worry about motivating others, rewarding workers, and punishing those who are not working. Ms. Stanford's 9th graders did not enter the classroom that morning wondering about the moon's rotation and revolution. But the respectful processes Ms. Stanford had established engaged the students in the enterprise of finding out more, and they worked to answer their own questions and to satisfy their own desire to know.

Ms. Stanford teaches in a mainstream setting with neighborhood kids. Ms. Frank teaches in a residential psychiatric facility for children and adolescents. There are 11 students in her class of 14-to-16-year-olds. A few of the girls are self-mutilators. A couple of the boys have drug-related problems. Some have physical challenges that accompany their psychiatric diagnoses. I was present in Ms. Frank's class on a day that she posed the same question Ms. Stanford had explored with her 9th graders: Why is it that no matter where we are on Earth, we see the same side of the moon?

Betty, Brian, and Gabriel formed a work group at the front table. They began their discussion in much the same way that most other groups typically begin: using one fist to represent Earth, the other fist to represent the moon. Then, they grabbed two balls from the pile Ms. Frank had put out. After about five minutes of discussion, Gabriel jumped up and got an earth science textbook from the top of the radiator several feet away. He commented that the answer was surely there. In a few minutes, he was able to find it:

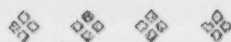
It takes the moon the same amount of time to rotate once as it takes to make one revolution. (Marshall & Roszkopf, 1988, p. 44)

The group's discussion ebbed and flowed. First they "had it," then they didn't. Gabriel correctly demonstrated the revolution and rotation process to Betty and Brian. Betty said she didn't "get it," and Brian (who did get it) said, "That's cool." Gabriel tried again, and then lost it himself. He thought for a moment and then correctly demonstrated it again.

Betty began her explanation, but Brian jumped in with, "Don't think about Earth's spin. It just confuses you."

During their conversation about the moon, I noticed Gabriel take Betty's hand in his, turn her arm over to look at her inside forearm, and ask, "You're not hurting yourself, are you?" Betty didn't answer. I also noticed that Brian asked Ms. Frank for cookies five or six times. She told him they would have snack soon. But when Brian started to ask more frequently, showing signs of agitation, she quietly gave him a couple of cookies. He ate them, and then rejoined his classmates' discussion.

One might ask what possible relevance the rotation/revolution ratio of our moon could have for teenagers so troubled that they are living in a locked, protected facility. But in this setting, far from the mainstream, we see many of the same quests to "find out" that we see in more conventional environments. Betty, Brian, Gabriel, and their classmates were curious enough about the apparently contradictory phenomenon that the moon rotates with the same half always facing Earth that they focused their energies for more than 40 minutes on an intellectual pursuit unrelated to the troubles that had brought them to that particular classroom. Ms. Frank had established a safe enough, respectful enough ethos that these students were able to look beyond their immediate world long enough to allow some relevance in another inquiry to emerge. In this achievement, there is a lesson for all educators. In order to create safe, respectful, intellectually rich settings in all schools and classrooms, we need to ask ourselves this crucial question: Which factors in my setting might I change to foster increased safety, respect, and intellectual integrity?





A Life in Search of Meaning

THE LAST CHAPTER BEGAN WITH EXAMPLES OF HOW OUR search for meaning is shaped by the questions we ask and ended with examples of how our search for meaning is influenced by the questions others ask of us. Let's continue our discussion of the powerful role that teachers play as provocateurs with good questions. In order to generate these good questions in the classroom, a teacher must have a firm grasp of the essential concepts of the topics under consideration. As Darling-Hammond (1998) states, "teachers need to understand subject matter deeply and flexibly" (p. 11). It seems like such an obvious statement to make: To have safe, respectful, intellectually rich school environments, we need teachers who understand the overarching content and processes of those environments. Yet, we must examine this statement further if we are to use its nuances to enhance school renewal.

Shulman (1987) describes the attributes of skillful teaching in terms of teachers' subject matter knowledge and knowledge of pedagogical principles. Throughout history, considerable debate has taken place over the professionalism of teaching, teacher qualifications, and the knowledge teachers need. To emerge on the other side of these debates with useful answers and reasonable plans, we need to understand what kinds of knowledge professional educators must possess and apply.

In my work with teachers at many different career stages, in many different environments, and at various grade levels, I have discerned two essential descriptors of accomplished teachers: (1) They have good working understandings of the

"big ideas" of the subjects they teach, and (2) they have a variety of questions and problems for exploration in their teaching portfolios. Just as a painter first creates a background in which to paint a foreground, these teachers present contextual problems in which they situate learning objectives. But finding an appropriate problem requires that teachers understand both the big ideas of the subject matter the class is exploring and the nature of their students' developmental profiles. It is this facility with the foundational concepts of the subject matter and the foundational concepts of developmental psychology that gives teachers the intellectual flexibility necessary to respond to the multiple perspectives found in classes of diverse learners.

Focusing students on a problem becomes the teacher's way of inviting them to engage in the learning process, and work toward meaningful understanding. Many parents I speak with respond to this point by saying, "Having a problem that students can actually work on is great, but teachers can't do that all the time. There are times when a student just needs to learn the concepts."

To continue the discussion, it is important for me to ask the parents to elaborate. "Tell me more about how you think students come to learn concepts," I say. Only when I can understand the point of view of the person with whom I am speaking can I appropriately address their suppositions concerning the topic at hand—concept formation, in this case. The same is true when a teacher engages with her students: To guide students in new learning, the teacher must first assess students' present perspectives and state of knowledge.

Traditional views typically characterize schooling as a one-way activity. However, the problems that frame meaningful exploration of concepts are not selected by teachers and given to students; they are negotiated between teacher and students. Boomer, Lester, Onore, and Cook (1992) describe curriculum as a negotiating activity that is reciprocal, constructive, and ongoing—one in which the teacher works within the learner's frame of reference to maximize the instructional potential of the curriculum. The Reggio Emilia Project, an early childhood program in Reggio Emilia, Italy (and the inspiration for countless early

childhood programs worldwide) is one well known example of an educational system based on a curriculum that originates with the child and is framed by the teacher. The next section illustrates some observable classroom interactions as learners search for meaning and the teachers in charge frame the search.

Teaching for Big Ideas

Teaching for big ideas keeps classrooms honest, real, fresh, and intellectual. *Honest* because teachers and students ask questions they truly want to answer. *Real* because the process of investigating answers takes the class down some unpredictable pathways. *Fresh* because teacher and students need new resources based on the new pathways. And *intellectual* because all members of the class, regardless of background, can find a conceptual leading edge—that place and that time that challenges them to consider what they think they know. Big ideas have few parameters. The thinker needs to impose them, or find them, or define them, and these are the processes that provoke deeper investigations of ideas and richer understandings. Let's peek inside some classrooms where this is going on.

Leap Year

One day in Ms. Bonaduce's 10th grade global history class, during an exploration of various time-keeping methods across cultures and during various historical eras, Adam asked the question, "Why do we have leap year?"

Another student, Mark, answered, "That's easy. There are 365 and one-quarter days in every year. After four years, you get an extra day."

Ms. Bonaduce then asked Mark, "Why didn't the calendar makers just make a year's calendar that had exactly 365 and one-quarter days?"

Mark's response: "Sorry, can't help you there."

Ms. Bonaduce wanted Mark and the other students to differentiate between a convention human beings constructed to help them keep track of time and the rate of Earth's natural orbit around the sun. When Mark "couldn't help her," she asked all the students in the class to separate the event to be documented (Earth's orbit around the sun) from the problem of documentation (how a calendar maker handles a quarter of a day).

Once the students distinguished between what an orbit is and human attempts to account for an extremely small leftover piece of an orbit, they were on their way to answering the leap year question while simultaneously developing skills in articulating problems and generating solution sets. In this case, Ms. Bonaduce didn't pull a contextual problem out of her teaching portfolio; she highlighted Adam's question and Mark's partial answer for further examination by the class. She framed the question initiated by one student and the answer volunteered by another student in terms of "the trouble we humans have keeping track of natural phenomena in a way that's easy for us to handle."

A similar "keeping track" problem that many secondary schools have is how to fit the many options for classes into a five-day week. As a mechanism to handle the "unnatural phenomenon" of their course offerings, some schools set up an alternate day schedule or a six-day rotation that overrides the five-day school week. Ms. Bonaduce, looking to teach big ideas, used her school's scheduling analogy to frame an investigation of the reason for leap year. This imperfect analogy actually served to provoke a good many other student questions, which, in turn, became the source of the teaching and learning occurring in the classroom.

Ms. Bonaduce can help us understand why it's important that teachers have a focus on and flexibility with the essential concepts and learning standards that inform a subject matter study. Understanding how various cultures solve problems and understanding how technologies both impose limitations and provide advantages in the problem solving process are two big ideas in many global history classes. Understanding the relationship between natural phenomena and socially constructed phenomena is another. Ms. Bonaduce is appreciative enough of

and facile enough with these learning standards within the social studies discipline to be able frame her students' questions in ways that can realize the learning potential of these questions. She negotiates the curriculum with her students.

Water, Water, Everywhere

Down the hall, in Mr. Theodore's class, students were investigating the properties of water. Ice can melt and water can vaporize. Students and teacher discussed the breaking of bonds and the fact that energy is required to do such. Mr. Theodore then asked his class, "Does it take the same amount of energy to melt ice as it does to vaporize water?"

Knowing when to ask what question is key to teaching big ideas. Here, Mr. Theodore first made a statement of content knowledge ("It takes energy to break bonds"). Then, by following up with a contextual question about how much energy might be required in different situations, he framed a perspective within which students could consider that information.

Students around the room reached for textbooks and searched for the reference tables. A collective "Ohhh," arose as they located the information they needed to answer Mr. Theodore's question: The energy gained during melting is 80 calories per gram of water. But the energy gained during vaporization is 540 calories per gram of water. So it takes a relatively large amount of energy to vaporize water when compared with how much it takes to melt ice.

Mr. Theodore pressed on. Does this reference table information explain why evaporation can be used as a cooling process? Might this explain why the misting machines on sidewalks in dry climates like Palm Springs, California, are so effective in cooling the area? Might this also explain why sweating is the body's mechanism for cooling?

The students needed to process much information and sequence many logical steps before they could answer these questions. Mr. Theodore had effectively framed an intellectually rich environment in which his students could grapple with the ideas related to the properties of water. The subsequent time the class spent engaged in the process of answering con-

textually bound questions meandered through a host of instructional modalities and materials, including whole-class and small-group deliberation and experimentation; primary sources and textbooks; Internet searches for pictures of the Palm Springs misting machines; and interviews with people who had been to places that use the machines. Classroom events unfolded, prompted by students' thinking and directed by the teacher's judgment of which intellectually engaging and rigorous settings might best help the class understand the properties of water and the water cycle.

Quality is the heart of the matter. Some educators might ask Mr. Theodore, "Have you covered Standard 7.5.2 yet?" Others might want to ensure that Mr. Theodore was using the newly adopted "Learning About Water" instructional module. And in many schools, Mr. Theodore's attempt to acquire extra thermometers his students could use in their investigation might be met with a "Sorry, but the supply order was due last April." The irony is that the likelihood of anybody asking Mr. Theodore about the students' concept formation is slim.

I recently came across an article in a high school newspaper introducing the system's new superintendent. The student writing the article noted the new administrator's "novel philosophy about the educational process." The "novelty" was that the superintendent believed that the emphasis in the classroom must be tailored to learning, not to passing tests! Think of what this says about how many of our students experience "learning" in school.

"What Are We Doing Here?"

Spending so much energy ensuring that standards are "covered" and that specific materials are "used" diverts us from the critically important mission of our schools. Why do students come to school? They come to school to consider concepts they would be unlikely to consider independently, and when that happens in a form students can appreciate, they tell you. Consider these two comments, included in a thank-you letter a 5th grade class wrote to a guest teacher:

I had a lot of fun in your class making ice cream and learning stuff I have never learned about or ever thought about.

Thank you for giving me knowledge of things that are always around but I didn't know about.

We might argue with the notion that the guest teacher "gave away" any knowledge, but both children's comments remind us how energizing it can be to learn something new. In these days of standards-coverage, when we think of school, we rarely think of the joyfulness of discovery. Consider the following observation made by Jerome Bruner in 1962, long before the "explosion" of the information age:

One cannot "cover" any subject in full, not even in a lifetime, if coverage means visiting all the facts and events and morsels. Subject matter presented so as to emphasize its structure will perforce be of that generative kind that permits reconstruction of the details or, at very least, prepares a place into which the details, when encountered, can be put. (Bruner, p. 121)

Through Bruner's lens, the school's mission is neither to establish a coverage quotient nor to measure proficiency levels. Then what—or who—provides direction for educating students? Bruner (1962/1971) continues:

Finally, it is as true today as it was when Dewey wrote that one cannot foresee the world in which the child we educate today will live. Informed powers of mind and a sense of potency in action are the only instruments we can give the child that will be invariable across the transformations of time and circumstance. The succession of

studies that we give the child in the ideal school need be fixed in only one way: Whatever is introduced, let it be pursued continuously enough to give the student a sense of the power of mind that comes from a deepening of understanding. It is this, rather than any form of extensive coverage, that matters most. (p. 122)

How do schools focus attention on intellectual rigor, powerful thinking, and knowledge construction? The responsible adults in the learning community must create settings that challenge students' design capacities, foster student ownership of learning outcomes, and provide leading-edge opportunities. Skillful teachers help students attain progressively greater achievements, internalize more rigorous standards, and become more reflective learners. They do this through their own knowledge of content and their understandings of student disposition and ability.

Meaning: Lost and Found

Learning is a process regulated by the learner. Still, it is the *teacher's* responsibility to effectively guide students in the search for the big ideas comprising the topics taught in the classroom. As we all search for understanding, we sometimes construct new overarching ideas that help us make sense of more of what we see. But we also sometimes deconstruct new ideas as we realize they no longer serve the intellectual purpose we originally thought they did. Effective instruction, therefore, includes a tolerance for ambiguity, mistakes, and error. The following very common elementary school mathematical examples illustrate the difference between the rote learning of skills and the understanding of essential concepts. As you read, consider these two questions: (1) What's the distinction between learning skills and learning concepts as part of one's ever-expanding numerical literacy? (2) What role does error play in the learning of skills and the learning of concepts?

The Big Idea Behind "Invert and Multiply"

Let's begin by looking at the way that many teachers teach the division of fractions. They model a process: Change the division sign to multiplication, invert the divisor, multiply the numerators, multiply the denominators, then reduce the final answer. Here's an example:

$$\frac{2}{3} \div \frac{2}{9} = \frac{2}{3} \times \frac{9}{2} = \frac{18}{6} = 3$$

This is the instructional approach taken by Ms. O'Connor, an elementary school teacher in a standards-focused school system. After Ms. O'Connor models the procedural algorithm of "invert and multiply," she typically asks her students to cut out magazine pictures that show fractions (such as a photo of a pizza divided into 8 slices), and then she asks students to make up fraction problems for one another to solve.

Like many teachers who follow similar instructional paths, Ms. O'Connor views her lesson plan as standards-driven. Using the New York State Learning Standards for Mathematics, Science, and Technology (1996) as an example, she might code the above algorithm instruction as "using mathematical modeling" (Standard 3.4, p. 15); interpret the magazine cut-out assignment as "linking the abstractions of mathematics and the real world" (Standard 3.5, p.16); and consider the students' generating computational problems for one another as an example of students "becoming mathematically confident by communicating and reasoning mathematically" (Standard 3 summary, p. 15). Ms. O'Connor and many colleagues and parents may conclude that the skill was taught and the standards were covered. I conclude otherwise. I suggest that this approach to teaching the concept of fractional division does little to enhance the students' transferable understandings of the concept.

Try this experiment with your colleagues, or any group of adults. Ask them to provide an everyday problem in which division by a fraction is a necessary computation and then to provide some reasoning as to why one would change the division sign to a multiplication sign and invert the divisor.

First, most adults find this a very difficult challenge. Usually, they provide examples that are whole-number divisions, rather than fractional divisions: "Divide a pizza cut into eight slices equally among five students. How many slices does each student get?" To generate an answer, they scribble on a piece of paper:

$$8 \div 5 = 1.6 \text{ slices of pizza per student}$$

Although many adults agree that 8 can be written as $\frac{8}{1}$ and 5 as $\frac{5}{1}$, most reject this example as not "fitting the bill." They usually move to the recipe arena: "You need one-half cup of flour, but you want to halve the recipe. How much flour do you need?" When they follow the "invert and multiply" model, here's what they come up with:

$$\frac{1}{2} \div \frac{1}{2} = \frac{1}{2} \times \frac{2}{1} = \frac{2}{2} = 1 \text{ cup of flour?}$$

When they see the answer this model produces ("Too big!"), they often conclude that halving a recipe is an example of fractional *multiplication*, not division. After two attempts, many people exhibit frustration and won't try again. Some pursue the challenge for a while and are amazed to discover they can generate no ready response!

This is where the teacher can jump in and redirect the inquiry back to the rejected pizza example. Suppose there are two pizzas cut into eighths. How many students could get a slice? Or said in another way, how many students could each get one-eighth? Most adults immediately answer "Sixteen."

Let's write it as an equation:

$$2 \div \frac{1}{8} = 2 \times \frac{8}{1} = 16 \text{ students}$$

If only *half* of a pizza were available, how many students could get a slice? Or, put differently, how many students could each get one-eighth of that half?

$$\frac{1}{2} \div \frac{1}{8} = \frac{1}{2} \times \frac{8}{1} = 4 \text{ students}$$

Finally, the procedure produces what seems to be a reasonable answer.

All the adults who try this challenge are likely to be proficient at computing. But odds are, they did not have math teachers who invited them to explore number theory as an intellectual pursuit; they probably had math teachers who taught them the procedural algorithms.

What does a class that explores number theory not as a set of procedural algorithms but as an investigation of numbers look like? Let's take a glimpse inside Ms. Walsh's classroom. She begins the discussion of dividing fractions by challenging her students' current understanding of numbers. "How is multiplying by half the same as dividing by two?" she asks. Most people find this transition easier to consider than the reverse—that is, the transition from multiplying by two to dividing by half.

After the students have grappled with those conversions and with different-sized fractions sufficiently, Ms. Walsh may invite students into an exploration of the relativity of the concept of "one." This concept is essential to the study of fractions; the size of a fraction gets its magnitude from establishing the size of the unit on which the fraction is based. Ms. Walsh brings out a variety of materials students can use at will, including fraction bars, the classic manipulative often used when teaching fractions. Ms. Walsh asks them to lay out some length that they want to consider the "whole." Most students, through prior use of the fraction bars, will use the publisher's "whole," but students know that they can determine their own whole, if they choose.

All of the student's subsequent work is based on that first whole. Students find fractions and Ms. Walsh asks them to determine how many of each fraction comprise the whole or other parts of the whole. For example: How many eighths cover the whole? How many eighths cover half of the whole? The questions continue. Sometimes Ms. Walsh suggests problems and sometimes students do. Here's a sample of their work:

$$\begin{array}{rcl}
 1 & \div & \frac{1}{8} = 8 \\
 \frac{1}{2} & \div & \frac{1}{8} = 4 \\
 \frac{1}{4} & \div & \frac{1}{8} = 2
 \end{array}$$

↑
Try other numbers

What's the pattern?

Soon, mixed number problems are introduced:

$$\begin{array}{rcl}
 1\frac{1}{2} & \div & \frac{1}{2} = 3 \\
 1\frac{1}{4} & \div & \frac{1}{2} = 2\frac{1}{2} \\
 1 & \div & \frac{1}{2} = 2
 \end{array}$$

↑
Try other numbers

What's the pattern?

By writing mixed numbers as improper fractions and searching for patterns among the many examples, many students realize that their answers are larger than one. Based on the patterns they see, *they* start suggesting an "invert-and-multiply" trick.

Discerning these patterns is basic to the part/whole understanding of the division algorithm that will allow learners to include division of fractions into their understanding of division of wholes. These patterns are also basic to understanding how a whole number can be expressed as a fraction. Teachers like Ms. Walsh, who teach the division of fractions concept by spiraling back to the part/whole nature of number comparisons, are basing their new teaching on students' prior learning. The content of that learning grows out of processes basic in academic traditions. When teachers ask how the division of whole numbers by small fractions compares to the division of whole numbers by larger fractions, they are asking students to compare and contrast information and gather and sequence data. Teachers challenge students when they bring artistic and spatial processing such as searching for patterns, deferring judgment, and juxtaposing ideas, among others, into explorations of "common" mathematical concepts.

The Big Idea Behind π

Typically, number theory is presented as a series of discrete manipulations of numbers governed by established mathematical rules. Given such, most people do not distinguish between procedures in math class performed due to conventional agreement and procedures that emerge due to the relationships among variables over which people have no control. For example, we agree to use the symbol $\cong$ to mean "approximately equal to." We could have chosen another symbol, but that's the one we settled on. We also agree to use the Greek letter π to represent the long, nonrepeating number 3.14. But we didn't agree on the number that would define the relationship between circumference and diameter. It just turns out that dividing the circumference of a circle by the diameter of that circle always results in 3.14, regardless of the size of the circle. Big or small, the circumference of a circle divided by the diameter of that circle is always the same: 3.14. That's pretty amazing! And it is downright exhilarating to see that constant emerge from measurements one takes oneself.

Unfortunately, math students rarely have the opportunity to discern these types of patterns from data they collect themselves. Teachers typically present the patterns. The fact that the patterns are presented by the teacher rather than generated by the student is a pedagogical problem. But when those rules, formulas, and constants are presented in a seemingly arbitrary way, we also have a mathematical problem. The study of mathematics is largely the study of patterns and relationships. We lose the magic of mathematics when we reduce the discipline to sequential, discrete facts.

Big Ideas and Details

Learning is richest when teachers and students strive for excellence within the context of mutually defined goals. If a math student is generating imprecise calculations, the teacher needs to assess the nature of the problem. Is it the student's inaccurate determination of significant digits somewhere in the calculation? Is it an inaccurate step in an algorithm? Is the student not familiar with an algebraic symbol? Is the student answering a question that's different from the one the teacher *thinks* the student is answering? Or are there other possibilities? When the student cares about finding next steps and the teacher searches for pathways to those steps, the student and teacher are engaged in the type of educational discourse and activity that results in increased learning.

Schools can only accomplish this sophisticated teaching task if the professionals working in those schools have deep understandings of essential patterns and principles and of the cognitive demands embedded in the concepts students are learning. Those concepts can be the classic ones associated with academia, such as the use of metaphor in literature, or the social-emotional ones of community life, such as the use of adaptive strategies for dealing with stress and pressure. Whatever the concept, the teacher's mission is to help students transform their original understanding of the concept into a

newly forged one. The teacher can only be a proper guide if the teacher has engaged in a thoughtful study of the concept and has culled out its essential components.

Not all factors contribute equally to the development of an understanding of a concept. There are overarching ideas and there are supportive ideas. Teachers who study their students' construction of ideas over time become more effective in designing instruction. For instance, in our " $C/D = \pi$ " example, teachers must distinguish first for themselves, and then guide their students in differentiating between the arbitrary conventions in the mathematical world (the substitution of fractional notation for the division sign in algebra, for example) and the emergent patterns from mathematical relationships (the division of circumference by diameter always yielding π , for example).

Many people perceive teaching as the act of shepherding students through a sacrosanct syllabus. Those who think that way often also think that if the teacher can do this and simultaneously exhibit a kind nature and patient disposition, so much the better. Within this framework, teachers are viewed as passing on what they already know. But teaching at its finest requires the intellectual capacity to co-create a learning setting that dynamically investigates the concepts of the syllabus. Teachers are not merely passing on what they know; they are using that knowledge to design and lead a focused, productive investigation of the concepts. To lead this search for meaning, teachers need to be able to separate the "big ideas" from the details.



PART II:

Unlearning Lessons Learned in School

ARE WE OFFERING STUDENTS THE EDUCATION THAT we think we are, or are we really sending messages we would be wise to change? Part II takes a close look at some typical school activities that subtly encourage children to be passive and passionless, to accept what is taught without the questions critical to true understanding, and, unless they are deemed exceptional in some way, to slip quietly into anonymity. Chapter 4 describes lessons with lots of talk, but few conversations. Chapter 5 illustrates the isolation, regimen, and acquiescence common in schools that require students to merely show up and follow directions. Chapter 6 portrays students memorizing many facts, but learning few principles. These chapters demonstrate with true stories from real schools that the messages encouraging voicelessness and detachment can begin in some unexpected places, places that on the surface can look not only acceptable, but engaging, concerned, and even festive. It is important to recognize these places and circumstances, because they require notice . . . and require change.

Dispiriting Lessons and Missing Conversations

OFTEN SAFE, DISCIPLINED, AWARD-WINNING SCHOOLS CAN mask the counterproductive lessons taught there. Test scores can be high, attendance superlative, behavior cordial, and bathrooms clean. The principal can greet students by name, and the PTA can host thank-you lunches. In these schools, you won't see the raw sewage, exposed steam pipes, and deteriorating walls that Jonathan Kozol (1992) depicts so vividly and sorrowfully in his descriptions of the school life of so many urban youngsters. But you might find the same emotional emptiness and disintegrating sense of self.

Questions of Climate

Economic and physical climates are not automatic determiners of school quality. In my travels, visiting schools throughout the United States, taxicab drivers in a number of urban areas have assured me that the schools in their cities are "the worst." After the drivers drop me off at these "bad" schools—typically public and typically in poor neighborhoods—I observe and work in the classrooms and often find very skillful, committed teachers and very skillful, committed students. I also find teachers and students with few skills and little commitment.

On the other end of the economic scale, I have visited schools in communities where average home prices are in the millions of dollars. At one private school, cypress trees had been imported and planted on the grounds because the founding director liked looking at them. The children who attend this school have parents so famous and affluent that teachers are instructed to never repeat students' surnames in front of visitors. Yet here, as in all the wealthy public and private schools I've visited, I found the same diversity in teacher and student skills and commitment that exist in the schools in middle income and poorer areas.

If I had to choose between a dilapidated school and a clean, maintained one, I'd pick clean and maintained. If I had to pick between a principal who knew the students and one who didn't, I'd pick the one who did. There are basic resources and practices that must be established and in place before we call an institution a school. But through my work with educators across the nation and around the world, I have come to know that the most significant merits of a school system rest in the learning climate that the teachers establish in the classroom, the social-emotional tenor that the school administrators create in the school, and the integrity of the central office administrators' interaction with the community.

How does a teacher create a climate in the classroom conducive to learning? He gives each student the chance to be heard. How does a school administrator create a positive social-emotional tenor in the school? She gives each teacher and each student the chance to be heard. How do central office administrators exhibit integrity within the larger community? They give each student, each teacher, and each parent the chance to be heard. It is easy to stop listening, but it is hard to be voiceless.

To experience life as voiceless is an alienating and lonely enterprise. The recent incidents of fatal and destructive school violence shockingly demonstrate how disaffected any particular student can be. The stories behind the violence tell us that although there are myriad factors outside of the school's domain that contribute to violent behavior, part of the young assailants' rage is a function of their treatment at

school. Today's students spend a great deal of time in school being voiceless. So do teachers and parents. We must examine ways to keep all members of the learning community engaged and nurtured.

Lessons Learned

It is often difficult to recognize, but in subtle, socially encouraged ways, too many of our schools teach children to be passive and without passion, to accept what is taught without the questions critical to true understanding, and to slip into anonymity. This is not what anyone wants to happen. So how does it happen? Where does it all begin? I contend that it begins in some unexpected places: in the festive Field Day, in the well-managed math class, in the reading readiness corner, in the aftermath of parent-teacher conferences, in a teacher's feedback on homework assignments, at tryouts for the Glee Club. Let's take a closer look at these typical school activities with an eye for the subtle messages that encourage voicelessness, disconnection, and disaffection in our schools. These are the messages that require notice and require change.

Winners and Losers

Here is a story of a mother and her daughter, Kate, who both showed up for Kate's first Field Day with great expectations. At Open House, the principal assured parents that the "dreaded gym class" of days gone by had been replaced with classes that encourage lifelong participation in sports and the disposition to lead a physically active life. But as it turned out, physical activity was not a hallmark of Field Day—a two-hour experience in which kindergartener Kate sat quietly for all but three minutes. If not for a lucky lottery draw that allowed Kate to participate in the water balloon toss, her participation time would have plummeted to 30 seconds.

At the end of the day, as Kate and her mom were heading home, Kate pointed across the field and asked Mom, "What's that table over there for?" Mom didn't know, but Kate found out the next day at school and shared the news at dinner. "That table was the winners' table," she explained. "I never had to go there because I was a loser."

Indeed, Kate had not won any of her events. She was not the last one holding an intact balloon, nor was she the fastest sprinter, nor did her partner and she three-leg it over the finish line before everyone else. No, by her own proclamation and that of the school, Kate was an official loser, and the volunteers at the table "over there" kept accurate track.

"Change Field Day?!" The assistant principal wrinkled his brow when Kate's mom appeared at his office door. "That's up to the physical education staff."

"Change Field Day?!" The gym teacher grimaced. "The parents love Field Day, and the kids look forward to it all year. No one else has ever complained."

And the gym teacher was right. Kate herself loved Field Day. She loved sitting on the sidelines, watching the events, and talking with her friends. She loved knowing her mom was there behind her—not there to talk or interact or offer a comment about anything—but just to be. Smiles and waves; that's what she wanted from Mom. But Kate's mom wanted more for her daughter. So she looked in books for samples of noncompetitive games, which she photocopied and forwarded to the gym teacher and assistant principal. She also bought the school a copy of Alfie Kohn's *No Contest* (1992).

By the time Kate was in 2nd grade, the school had a new assistant principal and once again, Kate's mom tried to start a conversation about a new kind of Field Day. The administrator's response ("That's an interesting point you're making,") was not encouraging. As a 4th grader, Kate watched Mom set up her folding chair alongside the Field Day field, watched her smile and wave, and watched her fold her chair back up and leave. As in years past, the "winners" made their trips to the winners' table; the "losers" sat quietly on the sidelines.

Kate is no longer at this school. But Sarah is, and now there's a new assistant principal and a new type of Field Day. Kate's

mom would have been thrilled; Sarah's mom is not. Sarah's mom wishes the school had left Field Day alone. "Now there are simultaneous games going on all over the field," she says. "The school wants the parents to play with the kids, and there are no prizes. I liked it better the way it was."

Change is hard for everybody. Kate's mom wanted Field Day to change, and for her, it didn't change quickly enough. Sarah's mom laments that it changed at all. Sarah's mom sees no point in parents going to the event if there are no prizes. Kate's mom sees no value in anybody going if there *are* prizes.

Consider how the climate at this elementary school might be different if parents spent time at PTA meetings discussing the research and the theories of collaborative versus competitive environments. For one thing, the next generation of elementary school parents would have a chance to consider new viewpoints. The school owes them the chance to listen, reflect, question, and propose options. Giving parents the opportunity to critically and creatively consider the issues important in school design is just as important as giving Kate and Sarah and their schoolmates the opportunity to critically and creatively consider the issues important in their school topics.

At this point, many of you may be shrugging and thinking, "Why would the PTA need to question Field Day? Or talk about research? Winning and losing is part of life. Adults accept that and kids should get used to it." Childhood need not mimic adulthood in order to help youngsters prepare for it. It's true that effectively dealing with disappointment and loss helps people live longer and happier lives. But it's not familiarity with loss that helps adults cope with death, abuse, neglect, and various other negative experiences; rather it's the internal strength that comes from a childhood that has known the warmth of safety and the comfort of community. Yes, the PTA *does* need to talk about issues like Field Day because Field Day represents the community. What we get together to celebrate reflects who we are and what we value.

"That's All I Need to Know"

Learning that one is a loser (but that it's okay to be a loser) and that most of life is spent on the sidelines (but that's okay, too) are two lessons that many students learn in school. Another is that learning is something finite, accomplished, done, and over at a certain point. Let's meet Abigail. Abigail's teacher handed out the following types of homework problems to help the students learn how to find equivalent fractions:

Find the Equivalent Fraction

$$\frac{2}{3} = \frac{?}{?}$$

$$\frac{2}{3} \times \frac{\square}{\square} = \frac{?}{?}$$

Having trouble figuring out just what numbers to put on the blanks, Abigail asked her mom for help. Mom, who remembered Abigail's previous homework assignments that focused on reducing fractions, tried to get Abigail to look at this assignment as a backward version of what she had already done.

"Remember your homework from last night?" Mom asked. "You looked at each number and thought about what other numbers you could divide each number by evenly?"

Abigail sighed in frustration. "I don't need to know that, Mom," she said. "You times this and this by this! That's all I need to know."

Exasperated at what she thought of as her mother's unrelated questions, Abigail clarified for herself the strategy her teacher had presented and then successfully completed the 15 items on the worksheet. Unfortunately, her successful completion of these homework problems and the former sequence of problems does not indicate Abigail has an ever-integrating understanding of the part/whole nature of fractions, the relativity of the concept of "whole," or the mechanics of how one

manipulates fractions to compare or find equivalency. These are the deep, complex understandings that lead to independence in mathematical problem solving. But right now, for Abigail, one strategy is separate from another . . . presented on separate worksheets, on separate days.

The apparent advantage of the worksheet is that it's easy for everyone to know when the homework is finished. The next day, it's easy to find out "how you did." With worksheets, learning is measurable, reportable, visible, and as long as you put in the time, it's even pretty comfortable. The worksheet also makes learning seem equitable: Everyone has a chance to succeed. But we pay a high price for this artificial simplicity. So much energy goes into keeping the approach simple that we forget learning mathematics is not simple at all. It's complex, just like eliminating world hunger, disposing of nuclear waste, balancing consumption and conservation, and solving almost any other problem you can mention. Why, when we know that the world is complex, are we teaching our children how to handle only predigested problems and, as a result, to feel uncomfortable approaching challenges that are more complicated?

The price we're paying is too high. Today's simplicity is tomorrow's ignorance. Today's orderly classroom is tomorrow's chaotic world. Students who stop questioning because they have finished all the problems are not tomorrow's problem solvers; they are tomorrow's bystanders. We are wasting our youth's talents by having them answer the odd-numbered problems at the end of textbook chapters. Even if the problems are good ones, their context is so removed from the students' real world that students see no application.

"Cleaning the Oven"

Sometimes we make school too easy, and sometimes we make school too hard. Take Nick's story. Five-year-old Nick inherited his father's fingers—long, slender fingers that bend 180 degrees at each joint. Combine a kindergartner with hyper-extensive fingers and a kindergarten teacher committed to a reading readiness curriculum that teaches the alphabet by requiring students to cut out pictures of 1-inch apples during

"A" week and $\frac{3}{4}$ -inch blueberries during "B" week, and you get a fine example of schooling made needlessly difficult. You also get a very interesting parent-teacher conference.

When Nick's parents came in to talk their son's teacher, Nick's dad tried to put Nick's reluctance to tackle the fine-motor tasks of the "cutting out curriculum" into perspective. He held up his hands to show the hyperextensive fingers so like Nick's and admitted that even as an adult, he occasionally needs help fastening the small buttons on his collars. Couldn't Nick show his competence in recognizing "A" and "B" in other ways? The teacher responded that she doesn't like cleaning her oven, but it's still a job that must be done.

Apparently, this teacher views the curriculum as an obligation to be met, unpleasant as it may sometimes be. She meets her own obligations (cleaning the oven) and expects her students to do the same. The subtler message she's communicating is that becoming educated has its dreary side and we should learn early on how to cope with dreariness.

Most complex tasks do have a rote or tedious component. But are those the components we want to highlight? Is oven cleaning the metaphor that should leap to mind when we think of what it means to become educated, in general, or to become a reader, in particular? The responsibility of learning is a virtue that develops from caring about outcomes and developing ownership over the events that lead to those outcomes. Why do we portray responsibility as a chore to tolerate and execute? What a strange message to send our children.

"A Typical 6-Year-Old Boy"

Jake's mom and dad signed up for a parent-teacher conference at Open House Night, eager to hear all about their son's life as a 1st grader. Based on experience during Jake's kindergarten year, they knew enough about the school district to know what his teacher probably *wasn't* going to describe at this meeting. Theirs was a traditional district that prided itself on National Merit Scholarships, high standardized test scores, a high percentage of students going to college, and other similar measures of "success." There was not much investigative learn-

ing going on in the district's schools, not much puzzlement that needed clarification. So Jake's parents weren't expecting their son's teacher to share her excitement over any of Jake's discoveries. They knew that there weren't many opportunities for students to make discoveries. But they never expected the teacher to say what she did: "Jake is a typical 6-year-old boy."

Jake's mom and dad actually knew that before they went to the conference. They also knew that they are typical 40-year-old parents. Jake could be joyful, exuberant, witty, and caring. He could also be a beast full of fire and brimstone. They could, too. They are all typical. They are typical because they want to "count" in the eyes of those they love. They are typical because they search for meaning and try to find a path that makes sense, and because they want to laugh, play, and do good work. Jake is indeed typical . . . and so are his parents.

But when Jake's parents see their son take off in that yellow school bus each morning, they hope that he goes to a classroom where his unique qualities are sought and valued, his point of view is challenged and expanded, and his developmental needs are addressed. It's a tall order to create that kind of classroom, and even more difficult to do so within a school district with a competitive ethos and a trivial reporting system.

Let's consider Jake's 1st grade report card. There are checklists for reading, math, attitudes, and handwriting—the four major areas in which his district's 1st grade teachers assess student progress. Scanning the checklists, Jake's parents found that their son's recognition of beginning consonant sounds is satisfactory, as is his ability to write and identify the numbers 0 to 20, although (according to one of the few handwritten comments), "There are a couple of numbers he has trouble forming." Jake needs to improve on two of the three measures on the handwriting scale. His demonstration of fine motor coordination also needs to improve, a judgment that led Jake's mom to wonder wryly whether her son really needs a better gene pool. Wasn't the die already cast on that one?

The only other handwritten comment on the report card read as follows:

Small motor skills need some work. Jake has great ideas, etc.—just needs to be more aware of spacing and lines.

Notice that details concerning Jake's "great ideas" were left as an "et cetera," but his lack of awareness of spacing and lines was printed as a box on the checklist, written out in longhand as a comment for the permanent record file, and told to the parents in person as the first remark about him.

What's wrong here? Jake's teacher is a caring educator with a sense of humor, a highly organized and visually stimulating classroom, a dedicated concern for her students, and a sense of responsibility that spills over into summer months and school-year weekends. Can she truly believe that letter spacing is so important? Can she truly believe that predictable spelling homework every night, a test on Friday, and phonics worksheets will engender a sense of responsibility and foster the reading and writing processes? Are these the things that will evoke a love for learning?

"Where's the Middle?"

Ms. Bingham's 4th graders are studying geography. A recent assessment asked students to label unmarked Mercator projections of the world. Megan labeled the latitude line at 20 degrees north as the equator. Ms. Bingham marked that item as incorrect.

While returning the papers to the students, Ms. Bingham said to Megan, "Look where you put the equator."

"Yes, I got that wrong," Megan replied. "I thought the equator was in the middle of the world."

Ms. Bingham stopped. "The equator *is* in the middle of the world," she said.

"No," Megan said. "You just said it's below the middle."

The teacher was confused. "Why do you say that?"

Picking up her Mercator map, Megan demonstrated the procedure she had used to find what she thought was the equator. She folded her paper in half and labeled the latitude on the fold as the equator. Most clever—except the map had been photocopied off-center on the paper, a detail she hadn't noticed. Megan then inferred that the teacher's "incorrect" mark meant that the equator was *not* in the middle of the world after all.

Here we have an example of a student using logic and reason to change an initially accurate understanding of a concept to a reformulated, inaccurate understanding in response to a teacher's accurate grading of a paper. It was only the ensuing discussion between Megan and Ms. Bingham that clarified the miscommunication and allowed the student to return to her original thoughts.

What do we learn from this example? We learn that the learning environments in our schools are often artificial. Students engage in too many exercises that have too little applicability. If Ms. Bingham wanted to understand and extend her students' conceptions of the challenges of mapping the entire surface of a three-dimensional object on a flat piece of paper, why didn't she give them a cereal box to map? If she wanted to understand and extend her students' concept of the distortions of Mercator projections of the world, why didn't she ask them to take an orange peel and try to make it flat? Or, conversely, to paste a 4-inch by 8-inch picture onto a tennis ball? Trying to do either creates conversations about the distortions of a Mercator map: In the orange peel case, there will be "holes" in the map; in the tennis ball case, there will be overlap. Only after students try to put the surface area of a sphere onto a planar surface for themselves can they appreciate the decisions of historical cartographers.

These are two examples out of many possible instructional approaches, used here to make the point that we develop transferable skills by recognizing our need for them and that we achieve competency using transferable skills when we engage in problems that require us to do so. Those "weird" maps of the world that have slices cut out make sense to a student after the

student has tried to flatten the orange rind. Teaching by telling and then measuring understanding through head nods just doesn't work when the aim is to teach students skills and ideas that they can use in the future, in settings different from the original learning setting.

Glee Club as an Oxymoron

Other strange messages emerge from supposedly delightful school activities. Consider the example of an elementary school of 900 students, with a thriving weekly Glee Club open to 5th and 6th graders. There is a weeklong tryout period for Glee Club, during which all interested students have a one-minute, private audition with the school's music teacher.

One year, 5th grader Jenna was among the 183 students to audition. Her 6th grade friend, Andrew, home with the flu, missed his audition, but rescheduled an audition with the music teacher the following week. Soon after, the club's roster was posted: 180 students were selected; three "didn't make it." Jenna didn't make it. Andrew did.

A few weeks later, unbeknownst to each other, both Jenna's dad and Andrew's mom wrote a letter to the music teacher. Jenna was terribly disappointed not to make the Glee Club, her dad wrote. She loved to sing and had been looking forward to singing with the group. Might the music teacher reconsider, and let Jenna join? The letter Andrew's mom wrote to the music teacher explained that Andrew loved to sing, and last year, he had enjoyed Glee Club immensely. But now, Andrew was guilt-ridden over the thought that he had taken Jenna's place. He told his parents that he didn't think he deserved a place in the Glee Club because he hadn't made the originally scheduled audition. Andrew's mom implored the music teacher to take Jenna so that Andrew could resolve his moral dilemma and regain his joy in Glee Club.

The music teacher responded to Jenna's dad by saying that she was sorry, but Jenna could not participate in Glee Club because the risers held only 180 children, and Jenna wasn't in the top 180. But she offered Jenna the chance to attend rehearsals and turn the pages of music when the teacher

played the piano and the other children sang. (Jenna turned the pages for three rehearsals and then dropped out.) The music teacher never responded to Andrew's mom. Andrew continued in Glee Club and never talked about the tryouts again.

Scripts That Suppress

There are many important conversations that aren't taking place at the school that Jenna and Andrew attend. These missing conversations, and the conversations missing at Kate's school with Field Day, Abigail's school with the math worksheet homework, Nick's school with the alphabet curriculum, Jake's school with the report card checklist, and Megan's school with the geography worksheets are fundamentally damaging the prospect for school renewal. Why? Because these missing conversations indicate that we have not institutionalized reflectivity into our standard practice.

Standard practice in education must be based on the wisdom of the profession. That wisdom emerges from the collective contributions of the educators, parents, and students in a school. All members of the school community need a forum and a protocol for initiating a study of a problem, investigating solution pathways, and reaching a decision.

Imagine a school that takes Andrew's moral dilemma seriously and takes Jenna's desire to sing sincerely. Imagine a teacher who thanks Andrew's mom and Jenna's dad for narrating their children's thinking about issues that the children may not have the independence to share for themselves. Imagine a principal and staff of teachers who dialogue with each other about ways to apportion space and resources to meet student needs. Consider this observation:

If we took seriously the notion that teaching is a cultural activity, we would begin the improvement process by becoming more aware of the cultural scripts teachers are using. . . . Becoming more aware of the scripts we use

helps us see that they come from choices we make. The choices might be understandable, but still they are choices and once we are aware of them, other choices can be made. (Stigler & Hiebert, 1999, p.101)

Perhaps the music teacher at Jenna and Andrew's school had a script that said "Affluent suburban kids are spoiled and their parents are overbearing." Some of the other scripts we hear too often include those that say "Poor kids are lazy and their parents don't care"; "Straightforward, concrete homework assignments will show parents that our school is accountable"; and "Kids can't do original research until they learn the basics." These scripts are subliminally suppressing efforts to revitalize and renew standard classroom practice. Every school must establish opportunities for all involved to examine these scripts, as Stigler and Hiebert advise, and to examine the utility of the pedagogical approaches that underpin that school's standard practice.

Let's look at one final example. In a school offering a summer recreation program, paraprofessional aides are responsible for escorting primary school-age students from swim lessons in the basement pool area to their next activity on the outdoor playing fields. One day, young Kelly's mother called to say that Kelly's aide had been arriving late after swim lessons. Her mother explained that Kelly became frightened while waiting all alone in the large pool area, after the older children in her class (who didn't need an aide) quickly dispersed and large groups of new children poured into the area for the next class.

A few mornings later, in the upstairs lobby to the pool, the aide assigned to Kelly looked at her watch and commented to a colleague, "I'd better get down there before the class ends, or else Kelly's mom will start complaining again."

Imagine a school program in which the aide might look at her watch and say, "I'd better get down there before the class ends, or else Kelly will be frightened." Not until *every* child is cared for, cared about, and taught appropriately can parents rest secure that *their* children will be cared for, cared about, and taught appropriately.

Showing Up and Following Directions

ON GRADUATION DAY, AS THE COMMUNITY LOOKED ON, THE principal of a fairly large middle school announced she would call the names of all those in the class who were graduating with high honors. I was in attendance, and assumed it would be like other graduations, where a small percentage of the class would be called to stand up. But to my surprise, name after name was recited. According to my quick calculations, 60 to 70 percent of the class was identified as earning high honors.

Next, each academic department called its own list of high honors, and with some exceptions, the same students were asked to stand. I began to think of the sitters, those whose names were never called. They were definitely in the minority. Were they, by exclusion, being identified to the community as the bottom third of the graduating class? In the last chapter, we discussed the many "losers" in the sport of school. Now, instead of being one of many, each "loser" was one of a few. Is this new approach an improvement? I don't think so.

At this same graduation, students who had volunteered for certain events during the school year were asked to stand. Then the parents of the recognized volunteers were asked to stand. The woman at the microphone told the gathering that these parents deserved a round of applause for having raised such fine children. Now, in addition to ranking students by their grade point averages, we're ranking them by their "fineness." And now their parents have gained special recognition for having done a good parenting job. Is it reasonable to assume that the standing parents have done a better job than the sitting parents? Is this

addition of selected parent recognition to graduation exercises an improvement? I don't think so. Changing small pieces of larger systems usually offers little gain.

When we think about this graduation celebration, we realize the system of ranking students is still in place; the only difference is that the top category is larger. A school that decides to recognize all students is changing the vision. A school that merely recognizes more students is changing the numbers, not the vision. In fact, one might argue that a school that recognizes more students may be doing more to create an underclass than a school that keeps the top group small.

Sometimes we need a dramatic shift in thinking to make a positive difference. But education is rarely characterized by much drama. Sadly, education, just like the graduation ceremonies that punctuate it, too often consists of showing up and following directions, the outcomes of which can be isolation amidst a crowd, order at the expense of sincerity, and perfunctory compliance instead of creative cooperation.

Understanding the Instructional Program

A few years ago, I was part of a team of educators hired to evaluate the middle schools in a suburban school district. My role in the evaluation was to assess the schools' instructional programs. My goal was to try to understand the types of teaching and learning going on in the schools by spending three days following typical students' schedules. Let's peek into a few of those classrooms to see the system at work and to look at the nature of the educational environments there. As you read, ask yourself: Do we need to fine-tune our educational environments or do we need a whole new vision of educational excellence? I think we need a whole new vision. Join me on this short journey to three different classrooms and one library and see if you agree.

Cool Teacher, Long Chats

When the bell rang for Mr. Kent's 8th grade science class, I counted 18 students seated in the rows of laboratory benches facing the front of the room. On this particular day, four students came in late.

"Oh, no, I have a run in my stocking," one student lamented.

"Oh, no, I have a hole in my underwear," a young man mimicked.

The latecomers entered the room noisily, and then settled into silence. Mr. Kent, a young teacher in his first year at the school, opened with, "We're going to have a test this week."

"What? Another one?" a student exclaimed.

The day's topic was momentum. Mr. Kent began the lesson by holding up two small rubber balls and asking, "If I drop these two super balls, what will their velocities be?"

While the teacher continued to speak, three students in the back of the room and four students on the side of the room chatted quietly. Mr. Kent's comments were liberally sprinkled with admonishments to the talkers. "Quiet!" he would say. Or "Hey!"

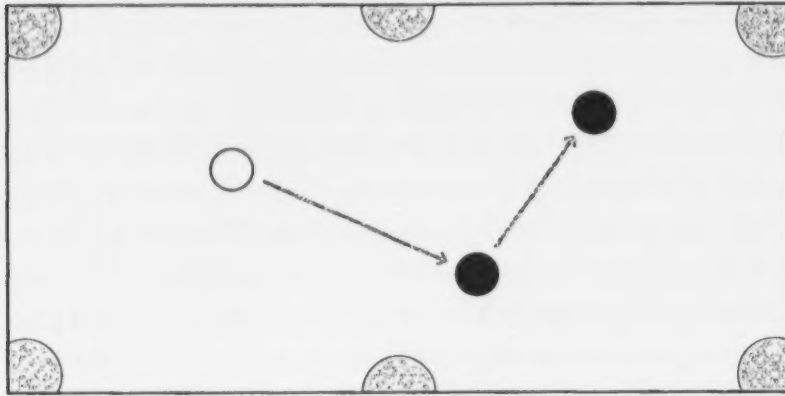
Mr. Kent went on with the lesson, placing the balls on the front table and writing a sentence on the board:

The momentum of a closed system can neither be created nor destroyed.

By now, at least half of the class was giggling, laughing, or throwing paper objects. When Mr. Kent turned his back, one boy approached the front table, picked up the super balls, and left the room for 10 minutes.

Mr. Kent next proceeded to ask and answer a series of questions. "Where do we see this in everyday life? Think about the game of pool."

He drew a diagram on the board:



A student seated in the front of the room asked, "Where does the momentum go then? What happens when the last ball stops?"

Mr. Kent redirected this question to a student. "What do you think, Kim? . . . Kim?"

Kim had not been listening. She looked up, blank-faced. Her classmates broke into a chorus of "A-ha, Kim!"

Mr. Kent did not answer the student's question about momentum, nor did he refer back to the diagram. Instead, he said, "Here's a simple problem," and wrote on the board:

A car weighing 1,000 kilograms travels east at 10 kilometers per hour. It hits a truck weighing 5,000 kilograms that is at rest. If the car is at rest after the collision, what is the velocity of the truck?

"We do this in math!" one student commented.

According to my count, six students attempted to solve the problem. The rest? Well. . . .

During the 42 minutes of Mr. Kent's science class, most students were off task most of the time. While the teacher tried to steer the conversation in one direction, there were at least three other conversations occurring simultaneously. After the dismissal bell rang, two girls (who had combed their hair and

chatted throughout the period) approached me to tell me how much they liked Mr. Kent . . . because "he's cool."

As far as these girls were concerned, young and handsome Mr. Kent didn't need to teach them any science at all. Those super balls didn't interest them, and they didn't play pool. The instructional program I was there to evaluate was far from their minds. These girls cared about being in school for and with each other. Their social connection with one another was their purpose in going to school. They told me that on Thursday, Mr. Kent would hand out a take-home pretest. They would complete the problems on the pretest, take the real test the next day, and probably get what they usually got—a score of about 85 percent. Then next week, they'd come back and do it all over again. Mr. Kent would still be cool and they would still be happy . . . and chatting away.

Cassidy and Her Homework

The next class on my agenda that day was 7th grade English. Before class began, a student named Cassidy told me about last night's homework, which, she said, was to copy vocabulary words into her notebook. Cassidy quickly added that she was angry with her mother, who (she said) often badgered her about never having any homework. In defending her own responsibility level, Cassidy asserted that she had done her homework last night and that it had taken her "three seconds." According to Cassidy, her mother "harassed" her (a term I hear used with some frequency among adolescents) by stating that merely copying the words down with no attempt to learn their meanings or usages was not the purpose of the assignment. She looked to me to agree with her that her mother was "making far too much of this homework."

I responded by asking Cassidy what she thought was the purpose of copying the vocabulary words. She changed her tone to one of disbelief, became very animated, and stated loudly, "There were only four words. We haven't even read the story yet, and all the teacher said was to copy down the words." Cassidy did not add, "And I can't believe that you can't understand that!" But that's what her eyes told me.

Class began then, but all I could think about was Cassidy. Did she really see homework as nothing but an obligation performed for the teacher? I suspect she did, and that for her, doing homework for the teacher didn't seem like an odd concept. The teacher wanted the words written in the book. Cassidy did it. That was that. Cassidy's mother appeared to expect more meaning from school than Cassidy did. The greater question for us to ask is, who's in charge of learning? It doesn't seem like Cassidy thinks she is.

Structured for Safety

Every 42 minutes throughout that day, I arrived at a new door and introduced myself. In almost all classes, the teacher told me to take a seat in the back. In one class, the teacher surveyed the empty room, thought a minute, then told me to sit in Row Three, Seat Four. I assumed the class would be full and was impressed with the teacher's visual memory: She knew which seat would be empty. But during the next three minutes, only nine students entered the room. Soon, I realized the seating was arranged so that there was an empty desk in front of, behind, and on both sides of every student. I was assigned a seat in the same pattern. I guess the teacher didn't want me getting too close to anyone either!

Class began, and the teacher sat on Desk One in Row Two. At her direction, the students opened their textbooks to chapter six, and each took turns reading one paragraph aloud. This went on for the whole period. There were no questions, no problems, no conflicts, no misbehavior . . . and likely, no learning.

After nine periods of taking notes, listening to directions, listening to paragraphs read aloud, getting assignments, and watching students review for tests, take tests, get tests back, and haggle over points on tests, I had to force myself to report for duty the next day. If it weren't for Cassidy and the two girls who combed their hair in Mr. Kent's class—the only three people who actually shared their viewpoints with me that day—I might not have returned at all.

Liberty and Justice for All

Five periods into the next day of new faces, in a new middle school with the exact same stories, I rebelled. Abandoning my schedule, I went to the school library, sat at a table, and watched. A student approached and asked me who I was. I told him. Another student heard us and wandered over. For the next four periods, students came and went, talking and listening for a few minutes and then moving on.

Twelve students stayed with me in the library until the end of the school day. At first, I tried to get them to go back to class. They told me they wanted to stay and that as long as I wrote them a pass, all would be okay. I agreed and proceeded to quiz them on what they were studying and what they were learning. As the final bell rang, they asked me if they could come back and see me again tomorrow. I overheard one of them tell a friend in the hall, "There's a lady in the library who you can talk to."

What did I learn from the students in the library? I learned they were highly concerned about fairness and could describe in exquisite detail instances of treatment that they considered unfair. They were very sensitive to embarrassment and awkwardness and were angered by teachers who shamed them or a classmate. They also demonstrated enormous empathy for classmates who (to use their term), were "mistreated" by teachers. A couple of 8th graders told me that earlier that day, a teacher had scolded one of their classmates, saying, "What's the matter with you? You should have learned this in 7th grade." They assured me that students in the school universally disliked this teacher. The reason? "You don't treat people that way."

Most of the students' comments dealt with interpersonal issues. I tried to steer the discussions toward the nature of learning. The students described their days as "going to class, listening to the teacher, doing the work."

"What questions are you trying to answer in those classes when you're doing the work?" I asked them.

They told me that they never knew until they got to class. It was clear that they perceived every school day as a brand new entity, similar in format to the day before it, but not very much

related conceptually. None of them could report on any long-term problem or question they were investigating. None of them had any anticipation of the conceptual quests of their classes coming up that day.

When I brought these comments to the attention of the school administration, they were worried about the lack of ownership of learning the students' behaviors and perceptions suggested. They were concerned about the emptiness the students reported, but happy to learn about it in a way that could be addressed on a whole-school level without pointing fingers of blame to particular teachers or departments. (When speaking to students, I didn't know their names or the names of their teachers. I just reported what they told me.) My observations in the classrooms, documenting curriculum tasks and instructional modalities, supported the students' perceptions. But it was the students' stories that meant the most to these particular administrators. Ironically, if it were not for my civil disobedience, I would not have been able to generate such a report.

No Problems, No Questions

In the middle schools I visited on this project, in a sea of people in the hallways but in classes that were quite small, I was very lonely. In most classes, I was invisible. That's okay; I was an official outsider and an official adult. But the students all around me seemed invisible, too, and that's not okay. At times, our eyes would meet and ask, "What are we doing here?"

In the few classes in which students worked independently on an assignment, I roamed from group to group asking them to explain how they were going about completing the assignment. They reported that the instructions were "right there." Again: no problems, no questions, and likely, no learning.

There's really no reason to be in school if there are no problems and no questions. Students are supposed to go to school to think about good questions and to solve important problems, or at least to attempt these activities. In trying to keep adolescents' emotionally tumultuous task of growing up under control, we once again squeeze real life out of school. We try to keep everything simple. But living a good life is not simple.

The instructions are never "right there." The students I spoke with thought that all they needed to do was show up and follow directions. And for the most part, they were correct. When we help students "succeed" in school when they invest no effort, we're setting a terrible precedent for our youth.

Beyond Showing Up and Following Directions

How do our schools come to set expectations so low? Some would say that in schools where most students don't show up or refuse to follow directions when they do, it's reasonable to cut back our expectations to those two "basics." But upon reflection, it's not reasonable—and it reduces the experience of schooling to a series of relentless chores. Showing up and following directions are not basics, they're byproducts; they come about when school activities make sense and are relevant to students' lives. Our schools' task is to create educational contexts that are engaging enough to prompt students to show up and follow directions, as well as to design, create, plan, devise, propose, build, produce, generate, and engage in all the other activities in which showing up and following directions are just pieces of a larger puzzle.

"Above and Beyond the Call of Duty"

To create engaging school environments that help students build the mosaics of their lives, we need school personnel who can see "the big picture." In Chapter 4, we looked at the familiar scripts that often define a teacher's response to a child or a situation. These scripts are understandings forged by unexamined suppositions. All of us operate with these internal scripts; they essentially serve the same function as the default values on a computer. Unless we purposively change the values, we're going to get the original settings every time. In schools everywhere there are teachers and administrators who cannot begin to

change their internal scripts until they examine their suppositions about what they and the students are doing in those schools. Let's meet Ms. Judd and consider some of the possible suppositions—some of the possible default values—that would explain her thinking.

During an after-school meeting with the principal, Ms. Judd, a middle school teacher and the president of the district's teachers union, described the faculty's dedication and how they extend themselves in their work, yet receive no recognition. Indeed, Ms. Judd said, in the hallway on the way to this very meeting, she had noticed a student playing hacky-sack (a game that involves using the knees and feet to "juggle" a small, round beanbag). She told the child to stop.

"It was after 3:00," she told the principal. "I didn't have to tell that kid to stop playing hacky-sack. That's an example of how we all go above and beyond the call of duty."

In Ms. Judd's school district, there are many teachers who go "above and beyond the call of duty" every day. Ms. Judd is typically not one of them. But there is Mrs. Haywood, a special education teacher who opens up her classroom from 11:00 a.m. to 1:00 p.m. throughout the summer so she can give individual attention to interested students and their families. There's the English teacher, Mr. Elliot, who corresponds with students by e-mail each night to answer questions about homework. And then there's Mr. O'Loughlin, a teacher of gifted and talented students, who regularly helps students with research interests to find the resources they need. The problem is that Mrs. Hayward, Mr. Elliot, and Mr. O'Loughlin do not have the political microphone. Ms. Judd does, and it is her voice that is heard.

What does Ms. Judd's statement reveal about her default values—her suppositions concerning the role of a teacher? Is a teacher primarily an authority with the power to control behavior, regardless of the reason for the control? Does her example of "dedication" actually enhance the image of the faculty in the mind of the principal or the larger community? Or does it do more to tarnish it? Does Ms. Judd leave meetings of this kind lamenting that teachers in general (and she, in particular) are not appreciated?

It's likely that Ms. Judd's script and the scripts of some of her colleagues are dramatically different. A good leader brings that conflict to the foreground so it can be examined and addressed. Examining and addressing conflict among adults in meetings is as important as examining and addressing conflict among students in the classroom. Teachers and administrators who do not address conflict lose too many important learning opportunities and too many opportunities to redefine the missions of our schools.

"I Don't Like This Stuff Any Better Than You Do"

Many teachers have shared with me their own lack of regard for various curriculum activities in which they engage. A lot of parents share the teachers' views. So we have teachers who don't think that what they are doing benefits students much and parents who agree with them. The fingers usually start pointing to the administrators.

"Scores will go down if we don't cover the material in ways identical to how the test will test it," some administrators state with conviction. The state education department officials disagree. They say the tests are not meant to dictate classroom practice. They say that tests are "merely a way of ensuring that schools get up to speed and stay there."

It looks like we are all a part of the problem. To solve it, let's recognize that the system of schooling in place today is rooted in a prior age. Let's highlight the good lessons we have learned, mourn the passing of what no longer is needed, and move forward to prepare fresh intellectual ground on which to build anew.

Learning What We Need to Learn

When we see our sons and daughters, nieces and nephews, and neighbors and friends go to school, we want to trust that they are going somewhere to learn what they need to learn. Students

need to learn about their places in the complex social dynamics of their schools and their communities. Those dynamics include parents with power, parents without power, teachers' personal value systems, administrators' supervision styles, honor rolls, detention rooms, auditions, poverty, affluence, and all the other elements that affect the tenor of schools and communities. Students need to be members of those dynamic settings in order to appreciate the need for their proactive engagement in improving those settings. Adolescents' schoolwork must take them into their communities, into the dynamic life of their environments. Passively listening (or worse yet, passively sitting and not listening) is a waste of time, talent, and resources.

We want to think of schools as simple places because it makes life easier to think that. Imagine if schools really were defined by blackboards and chalk, long hallways, and chairs and desks where students sit quietly reading the appropriate pages of their textbooks. We all know that schools aren't that simple, not even in the classes where students read paragraphs at well-spaced desks. Neither the adults nor the students in a school are one-dimensional. The adults come to school as parents who must rush home to drive their children to soccer; as household managers who must get to the bank before it closes; and as caregivers of the elderly who must schedule medical appointments. The students come to school as musicians with instruments; as athletes with game schedules; as workers with new jobs they need to juggle with schoolwork; as children conforming to or rebelling against family values; and as players in an unfolding drama.

Our task is to build a new model for schooling that reflects and respects this reality . . . a model that reflects and respects human complexity.



6

The True Negatives of False Positives

SIMILAR TO THE IMAGES OF MIDDLE SCHOOL EDUCATION depicted in the last chapter, the education offered to most high school students is rooted in the mimetic tradition, with teachers modeling and students copying. In class, teachers tell students what they need to know, and then, on tests, students repeat as much as they remember. If these sequential processes were indicators of effective teaching and learning, there wouldn't be a problem. However, they are *not* such indicators and there *is* a problem.

The problem is that much of the high school curriculum revolves around activities that too often result in "false positives." Students are passing tests, earning credits, and collecting diplomas, but they are not learning. Likewise, school personnel are passing out tests, documenting credits, and distributing diplomas, but they are not teaching. The reason: Everyone's hands are tied by the ropes of reason, not wanting to make waves or rock the boat. By trying to maintain the stability of calm waters, we rarely afford students opportunities to engage in the type of sustained intellectual behavior that is necessary for meaningful learning and we rarely afford school personnel opportunities to engage in sustained efforts to improve teaching and learning. Join me in this chapter's tour of four schools, all in different districts, but all with issues typical in today's high schools. I contend that recognizing the false positives in these stories, and perhaps in our own settings, will help us overcome the true negatives that underpin shallow successes. See what you think.

Focused to a Fault

Ms. Irving greeted by name the 15 students who walked in to her 10th grade Spanish class. The students took their seats in the rows of tablet chairs facing front. The room's cinderblock walls were bare.

That day, Ms. Irving's class was continuing their preparations for the state Spanish exam. First on the agenda was a review of previously graded work. One student questioned the teacher's check mark on a sentence the student considered correct. Ms. Irving explained that the check mark meant that the student's answer was correct. Another student asked, "What's wrong with mine?" pointing to a sentence marked as incorrect. A short discussion of the grading procedure ensued, but no real answer addressing what the student had done incorrectly emerged.

A student with a broken arm came in late, and Ms. Irving greeted him warmly. Then, teacher and students listed Spanish expressions of personal feelings on the board. Students seemed eager to go to the board. "Can I do one?" was heard four or five times. Ms. Irving asked students to elaborate on their first responses by transforming positive statements to negative statements, and negative ones to positive ones. This would be a task on the state exam, she noted. Ms. Irving also spent time giving students strategies for taking the state exam. "Don't even think about words you don't know," she advised.

The next task involved two students dialoguing at the front of the room. The students helped each other, and Ms. Irving offered assistance when needed. The students eagerly volunteered to participate and relished their chance to speak. The teacher exhibited a gentle, caring tone in all her interactions with her students. No behavior problems were apparent.

So what's wrong with this picture? What's wrong is that a caring, competent teacher, in pursuit of helping her students demonstrate emerging language proficiency, advised her students not to even think about the words they don't know.

On a timed, multiple-choice exam, it's a good strategy. But it's antithetical to real-world communication. It is a waste of professional talent to ask Ms. Irving, who knows so much about language and people, to suspend her role as a teacher so that she can be a test-taking coach. It's a waste of school time for students to learn test-taking strategies at the expense of learning language skills.

Students the Way They Are

One of the trends in school renewal efforts is for school districts to convene groups representative of the community, invite them to focus on the ideal, and then charge them with the task of creating from the ground up new visions of what the outcome of schooling should be. Ms. Tyler teaches English in a large high school that serves the entire district . . . a district that's in the process of "reinventing" its high school program. The first order of business: form a volunteer committee of the high school's stakeholders (teachers, community representatives, local religious leaders, and students), hire an outside consultant to lead the group, and charge the committee with the task of describing "the ideal high school graduate" and writing goals for what those graduates will know and be able to do.

A New Tradition?

Ms. Tyler predicted that this approach would do little to enhance the quality of education in her school. She joined the committee for the purpose of voicing her objections. A more constructive activity for the committee, Ms. Tyler argued, would be to refocus goal setting on domains in which the school had control. Defining what a student "will become" is beyond that control; however, schools *can* commit to creating environments and adopting practices that maximize the likelihood that students will develop good traits and skills and will transfer their learning to new settings.

Ms. Tyler's arguments were not enough to sway the committee, which generated list after list of everything the ideal graduating student would know and would do and would think. And with every new list, Ms. Tyler reiterated her objections. When she concluded that the lists were indeed going to be written, she also concluded that they would be written without her! Ms. Tyler retreated to the background as various subcommittees pondered the lists and condensed the group's thinking.

Months later, Ms. Tyler received notification that a subcommittee was ready to unveil its first draft. Her interest was piqued. To her surprise, the "list of ideal outcomes" approach had been abandoned in favor of an approach suggested by one of the subcommittee members, the rabbi of a local synagogue. He had persuaded the group that the Talmudic tradition of writing a central tenet, then documenting the scholarly responses from various perspectives, was a format that would inform the goals-writing process. The result was a document with issues to debate rather than one-dimensional items to accept.

For example, the committee had identified the goal of "becoming a responsible citizen" and had raised the accompanying issue of how a school system might foster student responsibility to one's community. Would requiring every student to take a civics class be a good idea? If so, at what grade level? Would a community service option available for high school credit serve this purpose? If so, would the credit be required or optional? Would allowing high school students to co-teach elementary or middle school classes be a possible avenue by which to promote civic responsibility? If so, how would such an activity be organized and how would its merit be assessed? Discussing goals as issues intrigued Ms. Tyler. She was invigorated and eager to participate again, thinking that the process was not as hopeless as she had originally suspected.

The committee reconvened one month later, and Ms. Tyler showed up, hoping that in the context of their newly accepted Talmudic-style tradition, they could broach the distinction between goals for the students and goals for the institution. It turned out they couldn't. The "goals" part was sacrosanct, and the committee was intent on defining the image of the sought-after graduate. Instead of discussing how a young person devel-

ops civic responsibility—and the role that adults might play in fostering such—committee members opted to further articulate the attributes of the graduate they wanted each student to become: a person who would vote in elections, participate in recycling programs, volunteer in the community, and so forth.

At the meeting's conclusion, Ms. Tyler left with the intention of not returning. But she didn't need to make that decision, because she never received another memo announcing an upcoming meeting. The committee and the goals it had created both quietly disappeared.

Making Sense of the Story

What does the tale of Ms. Tyler's committee teach us? On this particular committee, community members and students outnumbered teachers, and neither the school's principal nor the superintendent ever attended a meeting. Is it conceivable that Ms. Tyler's high school would undergo much change if key administrators did not participate in the process of deciding what that change would be? Perhaps the district had no intention of "reinventing" its high school at all.

Or perhaps the committee's charge to "start from square one" in thinking about educational goals and the ideal graduate was too naïve to work. Is it possible to build a new high school over an old high school while people still work and learn there? Indeed, the school was by no means at square one; it had a long history, a deeply rooted culture, and an established set of priorities. How could the offerings from a committee charged to conceive of a school from its foundation be of help to a school that had no clear ground for building?

Or could this be an example of the old adage that the more things change, the more they stay the same? In order for a diverse group of people to agree to goals, the goals must be written in a fairly broad manner. Very broad goals often resemble one another and usually have little bite. For example, who could disagree that it's a good idea for high school graduates to be "responsible citizens" and "lifelong learners"? After seeing the goals and the description of the ideal graduate the committee generated, perhaps the district saw no need to

"reinvent" its high school. Were the newly stated goals and the newly imaged ideal any different from the old goals and the old ideal? Ms. Tyler didn't think so. To her, it looked like the committee was just tinkering with the standard that already existed. Maybe a little more emphasis on this or a little less on that might change who becomes valedictorian or who gets a diploma at all. But the "ideal/not ideal" model, looking very much like the former "win/lose model," would still be in place, and would still disenfranchise too many students.

Students need to be treated as whole people whose ideal selves emerge from accepting, challenging environments that do not try to impose where students will end up and how they will look when they get there. The best schooling environments are those that recognize students as they are, and encourage and challenge them to reach points they likely would not have reached by themselves.

One of Life's Experiments

Let's travel on to yet another high school to observe Ms. Lin, a chemistry teacher, and her student teacher, Mr. Silver. Both graduated from a teacher education program noted for its constructivist pedagogy, focus on reflective practice, and commitment to investigative learning. Prior to their student teaching experiences, Ms. Lin and Mr. Silver spent a year as teaching interns in a weekly interactive campus program, which involved using problem-based curricula to explore interdisciplinary concepts with students of varying ages. After each teaching session, they participated in a faculty-led round table discussion focused on placing the session's work in a context that they could apply to other settings.

Some of these round table discussions had focused on young students' conceptual changes with regard to scientific topics. For example, if the teaching interns reported that students were drawing conclusions unrelated to the data, the faculty leader might have directed the discussion toward naïve

conception research and the tenacity with which we all cling to current thinking. At other times, the round table talks had focused on interpersonal classroom interactions. If the teaching interns reported that one child took over all the materials and pushed other children aside, the faculty leader might have encouraged the interns to look into bullying behavior or the varying ways students reveal their ego needs.

As program participants, both Ms. Lin and Mr. Silver had shown developing skills in designing educational environments rooted in student problem solving. When I visited their school, I was especially eager to see how these two (a teacher in her fourth year of practice and a student teacher with a Ph.D. in chemistry) were teaching chemistry concepts.

Testing for Nutrients

The science labs many of us remember from our high school days remain essentially unchanged today. The background, objectives, and materials for the activity are carefully laid out; the procedures are sequential and precisely delineated; and the observations requested on the lab reports are usually followed by a blank space in which to write the answer.

The day I visited Ms. Lin and Mr. Silver, they were conducting just such a lab—one requiring students to test various foods to determine the presence of carbohydrates, proteins, and fats. The lab packet the teachers distributed had six pages of instructions. Here's an excerpt:

1. With a glass-marking pencil, label one clean test tube "S" for starch. Pour dry cornstarch into the test tube until there is 1 cm of cornstarch in the tube. Then add water to the test tube, to a depth of 3 cm.
2. Mix the starch and water by stirring them carefully with a glass stirring rod. Then set the test tube in a test tube rack.

Question A: What color is the mixture of starch and water?

The lab continued with directions of the same format and questions of the same nature: What color is the solution? What color is the water around the drop of Lugol's solution? What color is the mixture after stirring?

It is easy to infer why the writers of the lab were so specific in their directions: They wanted to ensure correct results. A water-soluble marker washes off in a water bath, so a glass-marking pencil is indeed a better choice. If students were to use dirty test tubes, contaminants might affect the results, so a clean test tube is a better choice. Labeling the tube "S" for starch is logical. Wet cornstarch is definitely hard to pour, so dry is better. Setting test tubes in test tube racks makes for a neat and safe lab environment.

So what is wrong with this lab packet? The most obvious problem is that the writer has solved so many problems for the students that there is little left for the students to solve themselves! But there's a larger problem also: There are so many details in this lab that the big ideas behind it get lost.

The day I observed this class, 16 students were in attendance, although 32 students were registered. (No more than half show up on any particular day, Ms. Lin later confided.) The 16 there that day went about the lab quite industriously, performing the tasks and answering the questions. Ms. Lin moved about the room checking homework and asking for missing work or notes for previous absences. Mr. Silver moved about the room, too, offering praise to students who were on task and encouraging those students not on task to get there. Students showed him their lab reports by fanning the pages proudly and declaring that they were answering all the questions.

I also moved about the room, but with a different intent. I noticed that many students had the correct answers on each answer-line. When I asked them what they hoped to find out through the tests they were performing, most said they were "trying to see what color it turned." But when I followed up with the query, "What does the color tell you?" they didn't know. I also noticed that many students were comparing the results of one nutrient test with the control test for another nutrient. Many of them did not know they were testing foods

for three different nutrients, nor did they realize that there were two other control tests after the first one. Despite this, most still had the correct answers on the lines.

The standard-issue lab protocol surprised me. But, as I walked around the room, seeing students reach over racks containing broken, jagged-edged test tubes, I became not only surprised, but also nervous! I picked up the broken tubes as I found them and gave them to Mr. Silver. He lamented that supply shortages forced them to use broken test tubes. When I commented that this was unsafe, he responded that the lab packet referred to test tubes, and he didn't want to use something else and confuse the students. Did he really weigh confusing the students with harming the students? Did he really consider potential confusion more threatening than potential harm? I don't think so. I think Mr. Silver had replaced professional judgment with making it through the day.

After the students left, I shared with the teachers my surprise that they would use a lab protocol that required more skill in following instructions than skill in scientific inquiry. Their candid disclosures during the ensuing conversation revealed much about why schools change so little:

"The labs were already photocopied."

"I already spend two hours a day after school grading papers. Where can I find the time to rewrite labs, too?"

"The student wouldn't know what to do if we didn't give them labs in a format they are used to."

"These kids have a hard enough time getting to class. I can't make them think too hard when they get here."

Remember, these statements came from two teachers who spent a year in a teacher-education program committed to the idea that the primary reason to go class is to think hard about new concepts. When Ms. Lin and Mr. Silver learned about classroom discipline, classroom management, and assessment practices, their studies were situated in terms of developmentally appropriate curriculum with the potential to emerge as relevant to students. Why had these two teachers abandoned skills they successfully demonstrated at previous times?

More quotes from our conversation shed some light:

"That stuff is fine for younger kids, or college-age students, or in a demonstration lesson, but we can't do that in a regular high school."

"I couldn't do that stuff with these kids. Maybe an honors group, maybe a different school, but not my classes."

"You can do that other stuff with after-school clubs when you have more time, but not during the normal school day."

"We learned how to teach in the ideal. This isn't the ideal."

Testing for Nutrients, Another Way

What's missing in this science class? Well, most obviously, the science. Adhering to what they felt was necessary prescribed procedure, Ms. Lin and Mr. Silver never really engaged their students in an inquiry of how to test foods for various nutrients.

What might such an inquiry look like? Ms. Lin and Mr. Silver could take the same lab, assemble all the same materials, have the same objective, and introduce the lab with the same background material. But instead of handing out six pages that tell how to perform each step and preempt all technical problems, they might challenge the student with the following.

Other researchers have found that Lugol's solution, Benedict's solution, beirut solution, and brown paper bags can all be used as testing agents to measure the presence of certain nutrients such as sugar, starch, fat, and protein.

Using the "known" foods (the foods for which nutrient combinations have been provided), design an experiment to determine which testing agent tests for which nutrient. Then use the information you generate and the conclusions you draw to determine the nutrient content of the "unknown" foods.

Many teachers might suspect that their students would not know how to proceed if given this type of laboratory challenge. They are correct. Typically, the initial responses students have to this challenge include "What are we supposed to do?" "How do we begin?" "Where are the materials?" "How much do we

use?" and "We don't know what to do." If a teacher plans to change the classroom curriculum to one that requires students to design their own investigations, this type of initial bewilderment must be expected.

In a chemistry class in which students must think through problems and design plans to generate answers, before students and teachers begin the actual experimentation with supplies and equipment they must first engage in a good deal of negotiation. There are conceptual questions to pose, reference manuals to consult, technical questions to ask, and logic and creativity to employ. The teacher must have laboratory supplies clearly labeled, with user-friendly hints and directions for proper handling. Students must form (or be assigned to) work groups and they must think through the problem individually—for homework, perhaps—before meeting in their groups to prepare a collective plan. After all members of the small work group have endorsed the plan, they might solicit feedback on their plan from another group. Finally, each group must list safety measures and secure their teacher's permission to proceed.

On the first few occasions that students work within this framework, teachers should expect to devote lots of time to "getting started." The ground rules have changed, and students need to become accustomed to the new methods. The up-front investment is worth it. The learning that occurs within these first few laboratory investigations has carryover to all subsequent ones, because not only is the content of the laboratory investigation part of the explicit curriculum, but the processes of the laboratory investigation are, too. Students investigating the nutrient content of food learn about nutrients, but they also learn a variety of laboratory process skills: how to measure quantities; how to describe, predict, and discern patterns in their findings; how to differentiate evidence from inference; how to control for variables; and how to engage in procedures central to research in many domains. Yes, students could learn these procedures through standard-issue lab protocols, but the crucial difference is that in this context students know what they want to do before they figure out how to do it. And when they engage in a procedure, they know *why* they're doing it.

Some teachers who try this "design challenge" approach to teaching abandon it before the approach has a chance to work. They see some students off task, or see a mischievous act, or see supplies being used up by students starting over, and they become so fearful of potentially wasting time or materials that they can't engage in the process of finding out the approach's benefits. Other teachers, wary of the unpredictability of what the students might generate, can't begin to change at all. Not all teachers are fearful of the approach; some just can't believe students are capable of "original research."

We are all capable of original research. Each of our unique lives is an example. We demand various levels of standards for our actions and hold diverse visions of the actions we want to take, but within our parameters we are all designers of our own life's big experiment. We can design the small experiments that comprise school life, too. Schools can be places that encourage the unfolding of answers.

Flexible Facts

Compare the "messiness" of the experiment-designing classroom and the intellectual challenges they present for teachers and students with the straightforward simplicity of the core curriculum that E. D. Hirsch (1987) advocates. A core curriculum presents to the teacher the specifics of what is to be taught, dovetailing with the standards movement. Although standards are often written with a focus on process, the tests that emanate from the standards demand familiarity with an essentially prescribed set of information. For instance, in the realm of history and social studies, each state has or is producing multipage documents delineating what each student in that state should learn, although as expected, this process is not without controversy. An article in *Education Week* had this

report on one state's difficulty fine-tuning its history standards document:

The president of the state board noted that a dispute between Americans of Armenian and Turkish descent over what to include about the history of the Ottoman Empire in the standards had dominated board discussions and had not yet been resolved. "The Armenians strongly urged the formal recognition of the Armenian genocide by the Ottoman Empire," he said. "The Turks disagreed with that." The board decided that the revised standards would require students to learn about the development of the Ottoman Empire, but the issue about whether they would be required to learn about a massacre at its hand would be taken up again in the writing of the teacher's resource guide. (Zehr, 2001, p. 26)

The Ottoman Empire: Required or Repressed?

The type of discourse the members of this board of education are engaging in will probably give them a better chance of generating meaningful understandings of the Ottoman Empire than will the curriculum they plan to offer their state's students. The board members are spending days on the topic, and it appears they are grappling with matters of domination and prejudice, as well as other issues that impact historical events. When they finally decide which facts about the Ottoman Empire they will expect student to know, and add these to all the other historical facts they will expect students to know about the rest of the world, it's likely teachers will be able to just spend minutes, not days, on the topic—far less time than the board of education has spent. I wonder how much the students will learn?

Yet the more powerful oddity in the whole situation is the irony this controversy evokes: Is the state board arguing over the necessary facts that comprise the literate public's knowledge base? Is the board of education debating whether or not

the genocide of the Armenian people took place? Is it the *fact* of the genocide they're debating or its *importance*? Its importance within the grand scheme of other genocides or its importance within the history of the Ottoman Empire? And just which genocide are they discussing? My edition of Children's Britannica makes no mention of an Armenian genocide in its article on the Ottoman Empire (1994) or its article on Turkey (1994). But the article on Armenia (1994) states the following:

During World War I, the Turks, who looked on Armenians as a danger to their country, deported over one million Armenians from Turkey across the border into Syria and Palestine. Around 600,000 Armenians are believed to have died. (Vol. 2, p. 23)

By World War I, wasn't that region called *Turkey*, and not "the Ottoman Empire?" Is this entire controversy really a historical debate over chronology? Or is it an educational controversy that hasn't even been fought yet? Wouldn't an educational approach that presented these events, or any subset of these events, as *facts* disrespect all the participants of those events, stripping them of their challenges, their reason, and their humanity?

What's Wrong With This Picture?

Again, we must ask: What's wrong with this picture? Many things. First, it's too dangerous for boards of education to try to exhibit these controls in a democracy that enjoys free speech protections. Second, it's too joyless for a child to go to a school in which teachers try to fill students heads with the "right stuff"—strings of facts unconnected to the essential issues that bind cultures and people together. Yes, when teachers tell students what state boards of education have told teachers to tell students, the "process of teaching" is simple. But it's also wrong. It creates no allure to learn more, unfolds no dreams. *It isn't teaching!* It's relaying information. It's a non-intellectual task for the teacher and a nonintellectual task for the student. We can do better.

PART III

Lessons That Last

THE PEDAGOGY OF THIS BOOK IS CONSTRUCTIVIST, and Part III describes this view of learning and teaching in more detailed, psychological terms than those used in Parts I and II. In these chapters, I contend that schools can be better than they are now and that they *would* be better if they were more constructivist. Chapter 7 explores knowledge. Knowledge does not consist of an amalgamation of equal ideas; rather, certain ideas subsume other ones, and sophisticated classifying schemes replace simpler ones. Chapter 8 suggests that just as students replace initial ideas with more sophisticated ones, so too must the professional community replace the current "isolated student" model of education with a new "community-of-learners" model. Chapter 9 presents examples of the types of curriculum in which students of diverse experiences and varying levels of prior knowledge can all participate successfully and productively. Chapter 10 concludes with a look into some of the common questions people ask about constructivist education, some of the common critiques, and once again, some of the classrooms that bring the ideas of constructivism to life.

Uncertainties and Imperfections

THE IMAGE OF SCHOOLS AS STURDY STRUCTURES WITHIN which students build ideas is very different from the image of schools as rich landscapes through which students cut their own intellectual pathways. Some students find comfort and direction in a framework of strength and organization. Some find comfort and direction in a fertile field with a handful of seeds. Can one school play both roles—as well as a variety of other ones—and still serve diverse students? The answer is yes, if the school embraces a unified pedagogy that holds the diversity together.

Suppose we define learning as a meaning-making process in which learners continually evaluate new information and experiences against their current theories, rules, or notions. Within this definition of learning, the role of school professionals and parents will always be one of addressing uncertainty. Administrators, teachers, guidance counselors, psychologists, social workers, and parents will always need to assess the learner's current thinking and, in conjunction with the learner, construct appropriate educational plans. As learners, each of us approaches new experiences with sets of pre-established beliefs and naïve theories that we change only when we cannot reconcile new data with currently held conceptions. The learning implied in this situation grows out of the integration, reclassification, and re-ordering of ideas. This is a constructivist view of learning.

If a school commits to a constructivist view of learning, the school professionals and parents must be adept at tolerating

significant levels of uncertainty, at sorting out key variables, and at responding to multiple needs simultaneously. In school settings in which learners are actively engaged in meaning making, there is plenty of perplexity and "beginning over again." The adults in charge of creating and maintaining the health of these settings must be able to deal with ambiguity, able to defer judgment, and able to stay focused in the face of distractions.

Risks, Gains, and Guarantees

Does a unified pedagogy guarantee success? It depends on the pedagogy and your definition of success. Within a constructivist framework, a parent might mediate a sibling conflict by trying to build a consensual understanding of the conflict between the two siblings. A psychologist might narrate a child's fear in order to reflect it back. A teacher might pinpoint a student's confusion in order to provide leading-edge instruction. And a student might fix a classmate's broken project in order to ease sadness. But as peacemakers, we can't guarantee peace; as empathizers, we can't guarantee comfort; as diagnosticians, we can't guarantee growth; and as collaborators, we can't guarantee friendship.

Although constructivist pedagogy doesn't guarantee a particular outcome, it does guarantee a process. A school's pedagogy states the school's mission and the values of the learning setting, thereby implying certain practices and strategies. These practices and strategies resonate with each other. They all aim toward guiding learners in developing and refining their ability to weave conceptual tapestries.

Contrasting Pedagogies, Contrasting Aims

Other pedagogies target other results. As a contrasting example, let's consider direct instruction (see Engelmann & Carnine, 1991). The direct instruction model offers many more guarantees than the constructivist model does and defines learning

very differently. In a direct instruction classroom modeled on the framework Bereiter and Engelmann (1966) suggest, lessons are completely scripted. The teacher is not a diagnostician, but a reader of a carefully worded document written to eliminate ambiguity and confusion. Learning is defined as successful mimicking of models previously presented. In a direct instruction classroom, it is not the learner's job to weave conceptual tapestries; this is what the scripts are designed to do. The learner is expected to commit to memory that which is illustrated in class. The teacher is expected to deliver a faultless presentation of material.

There are less-prescribed settings that can also be called direct instruction—settings in which teachers do not read scripts, but instead follow plans written by textbook publishers or curriculum designers. Schools operated in the direct instruction mode tend to offer guaranteed outcomes such as “by the end of the lesson, all children will accurately multiply a three-digit number by a three-digit number.” They guarantee, however, a type of learning that constructivist schools spend less time fostering. As a result, it is difficult to compare the successes of schools with different pedagogies because their educational aims are so different.

In the realm of elementary school mathematics, for instance, a direct instruction school might center classroom time on drills that help students commit the multiplication tables to memory; the quick recital of these facts is viewed as an important gain. In contrast, a constructivist school might center classroom time on investigations that help students find multiple ways of grouping large numbers; the students' interpretation of multiplication as a process of successive additions is viewed as an important gain. From a constructivist perspective, it doesn't make sense for students to commit multiplication tables to memory until after they explore the processes of multiplication fully enough to see related number patterns emerge.

We can see that gains sought by direct instruction schools are very different from the gains sought by constructivist schools. In a constructivist school, the quick recital of multiplication facts may be considered necessary, but is not considered sufficient. A *computational* focus on the study of multiplication

may yield quicker and more successful results on timed recitation tests, but it's unlikely to add to a student's repertoire of understandings of mathematical relationships (an imperative for further study). In contrast, a *conceptual* focus on the study of multiplication can do both. It is likely to yield important lessons that inform future studies and to provide a context in which recall of multiplication facts will be practiced and will have meaning beyond itself. What is learned depends on the readiness of the learner and the attributes of the learning environment. As a result, what is learned cannot be determined for certain.

What is certain, however, is that teaching and learning important concepts can never be faultless. It's a little like the process of becoming real Margery Williams describes in her 1922 classic tale, *The Velveteen Rabbit*. Living a life is too complex to be done perfectly. Understanding important concepts, like what it means to become real, is too complicated to be reached in a tidy manner and too taxing a process to look tidy when you're finished. We all begin to show our "seams underneath" (Williams, 1985, p. 6) and look "very shabby" (p. 8).

Imperfection: Just Right!

When it comes to education, our aversion to risk and the illusions of perfection to which we cling are misdirecting our energies. We seem to believe that if we have the right curriculum, students will learn what they are supposed to. If we have the right motivators, they will all try to succeed. If we have the right tests, they will prove their achievement. Maybe. But maybe not.

Perhaps the "perfect" part of our imperfect system of education is the process by which the teachers allow students to make their own errors without going too far astray. Maybe it's the way teachers jump in and ask questions to get the discussion back on track. Or maybe it's the way they don't jump in to ask questions, but instead wait until students have gone far enough astray to know what it's like to be lost in an intellectual sea.

The complexities of teaching make professional judgment a central ingredient of this imperfect system. The success of the teaching/learning dynamic rests with both the learner and the

teacher. But it is the teacher's ability to make good judgments that sets the stage for success. Those good judgments rest on holistic understandings of the environment and the students. How much time does the class have left that day? What resources are available at the moment, tomorrow, next week? What are the students' concerns, strengths, needs? What are the key ideas of the syllabus? What are the targeted learning outcomes? The teacher must answer many questions in order to act.

When parents send their children to school, they do so with the tacit agreement that their children's teachers will base their behaviors on appropriate sets of learning principles, appropriate sets of content area knowledge, and unconditional regard for the well being of each student. These are the guarantees an educational system can offer parents—guarantees about processes offered to every child at developmentally appropriate levels. Guarantees about educational outcomes? These guarantees reside within every learner.

“The Big Picture” Again

The “big picture” is a notion that surfaces again and again as we try to foster better learning. Any learner must grapple with the big picture before he or she is intellectually ready to learn the intricacies of the parts that contribute to the whole. We have much evidence that students can learn the intricacies of parts out of the context of the whole, but they lack the mental scaffolding that allows them to transfer that learning to new intellectual settings (see Mintzes, Wandersee, & Novak, 1998).

The work of David Ausubel (1963) provides many insights into the processes by which learners modify concepts. Over time, learners create new concepts that subsume prior ones. Additionally, as learners restructure knowledge through clarifying concepts, they develop a complex network of conceptual links within a hierarchy that differentiates among central, supportive and related concepts (see Ausubel, Novak, & Hanesian, 1978).

Let's use colorful autumn foliage as an example. Some advanced students can readily recite the reaction series involved in photosynthesis. They describe electrons flying off chlorophyll molecules, the reduction of NADP⁺, the formation of ATP, and the carbon fixation process. However, if you were to ask why sugar maples turn a wondrous orange and dogwoods a deep red, or what triggers the color change in the first place, many of these students would have nothing to say. Even though they have learned to recite sequences of chemical processes on levels more detailed than they have a need to understand, most can do no more with that sequence of chemical processes than recite it correctly on a test.

I argue that understanding the molecular interactions that describe photosynthesis before one has the chance to think about the role that decreased daylight, cooler temperatures, and decreased water supply have on leaf color has too little meaning. Students need to consider how a plant's ridding itself of leaves is helpful in winter or how a tree's preparation to jettison leaves is related to color change. Unless we have a working understanding of leaf color change on broad, colloquial terms, the detailed molecular terms have no intellectual home in which to reside.

The Need to Cluster Ideas

When learners endeavor to construct deep understandings of their worlds, a mathematical need to group those understandings emerges. As the work of Ausubel teaches us, learners seek to find more inclusive concepts in which to group less inclusive ones. For example, when we ask students to hypothesize why leaves change color, the students' answers provide rich resources for the teacher's instructional purposes. Misconceptions emerge. So do possible pathways for subsequent intellectual investigation. The teacher can help students develop the explanatory concepts that lead the way to greater understanding.

In answering the question of why leaves change color, students encounter information about carotenoids and phycobilins and other chemicals, which they may begin to group together as

accessory photosynthetic pigments. Or maybe they don't group them together. A learning opportunity emerges. Some students initiate questions about light absorption spectra; others don't. An opportunity to model collaborative discourse emerges. The teacher may question the intensity and longevity of the colors as the foliage changes. Do we need to know something about temperature? About water supply? What about critical values such as freezing points? The students start demanding more information and building more knowledge.

This example again emphasizes the important role teachers play in facilitating students' development of new knowledge. They do so first by creating settings in which students have a context and a purpose. Then, they often ask students to detect discrepancies and lead follow-up discussions designed to help students resolve those discrepancies. This discrepancy resolution can lead to the development of the more inclusive concepts described earlier as the necessary learning pattern of cognitive growth.

What students already know and how teachers structure current learning environments are important determinants of the future understandings students will be able to construct. When students investigate a phenomenon such as leaf color change, the teacher can negotiate the phenomenon or concept with the learners using subtle yet observable practices: creating settings with context and purpose, leading discrepancy detection, and fostering discrepancy resolution.

Replacing, Not Adding

Teachers seek to understand student readiness to generate certain types of knowledge by determining the students' present hunches, conceptions, and beliefs. Teachers then provide opportunities for students to confirm or refute those initial thoughts. Unless the confirmations or refutations come from the students themselves, the likelihood that they will generate understanding is compromised. It is the constant replacement of present understandings with richer and deeper ones—rather than the constant addition of understandings—that characterizes the processes of cognitive growth and learning. A learner's

knowledge can grow, certainly; but knowledge does not consist of an amalgamation of equal ideas. Certain ideas subsume other ones. Simple classifying schemes are replaced with more sophisticated ones. Some ideas are tweaked. Others are abandoned. This idea replacement can stir up many separation anxieties. Learners don't easily part with ideas. Learners often have to intellectually "carry around" a new understanding for a while before they are ready to give up the old one.

While students grapple with "replacement understandings" in the content areas, the professional community must consider replacing pedagogical models. We need to replace the model of individuals pursuing pre-established curricula with a new "community-of-learners" model in which cohorts of students pursue understanding in mentor-led study groups. Members of the study group communicate their current thinking with others by formulating and reformulating their thoughts based on peer and expert feedback and by reflecting on that feedback. Although the broad content areas are pre-established, the intellectual paths are not.

This latter model of schooling sets up contexts for learning with directed yet flexible goals, presupposes a characterization of knowledge as dynamic and socially constructed, and rejects the notion that knowledge is something static to be passed on.

Teacher Scaffolding

The community-of-learners model requires an intellectually curious, collaborative teacher who can lead the learners' intellectual discourse and activities to maximize the likelihood that meaningful learning will occur. Some level of intellectual dissonance must be established, either through peers sharing their diverse perspectives or through teacher prompts that highlight sources of cognitive dissatisfaction. Tasks must be within the students' collective reach—that is, more advanced than any individual within the group could likely complete independent-

ly, but not so far advanced that learning shuts down.

Teachers provide a framework for discourse at the leading edge of students' current thinking. This framework can include

- Questions designed to help students detect patterns.
- Contradictions designed to help students examine subtleties.
- Hypothetical comments to help students extend an argument.

The purpose of the framework is to help students restructure their current theories. As mentioned, learners of all ages are committed to the merit they attribute to their present thinking. Therefore, cognitive restructuring is resistant to casual interference. It can also be resistant to directed teaching. Much research (Camp, 1994; Clement, 1993; Driver, Squires, Rushworth, & Wood-Robinson, 1994; Resnick, 1983) discusses the difficulty teachers and learners face in dispelling the misconceptions to which learners cling.

Fostering students' restructuring of present conceptions requires teachers to analyze students' current perspectives with specific regard to the topic, concept, or issue at hand. While a casual observer in such a class setting may not readily see the underlying pedagogy, the pedagogy nonetheless exists, and it is powerful. It drives decisions about which responses to pursue, which student groupings to establish, which supplies to gather, and which follow-up questions to generate. Although significant differences exist among content areas, levels of complexity, and the goals to which students aspire, a binding construct for all individuals in teaching roles is a focus on better understanding students' conceptual changes over time, the nature of the changes, and the contributing variables (Novak, 1993; Von Glasersfeld, 1998).

Curriculum Rooted in Today

Most schools spend so much time trying to help students prepare for tomorrow that they miss the lessons of today. "Today" is very important for most people. For children and adolescents, it is likely to be the only time they consider important. So how can we use today to teach students the ideas of the

past and the skills of the future?

Let's select a "big idea" that a teacher might want to investigate and use it as an example. In Chapter 2, we looked at two classes investigating the ratio of the moon's rate of rotation on its axis to the moon's rate of revolution around Earth. The big idea of ratio and proportion is an essential concept found in many content areas. For many of you reading this book, accomplishment evidenced on the now out-of-print Millers Analogy Test was the ticket into college. Test-takers had to successfully determine that "foot is to sole" exemplifies the same relationship as "hand is to palm." There are no numbers evident in these analogies, but their cognitive demand is similar to the mathematical notion of proportion, and this type of demand is echoed in a number of domains that don't immediately appear to be mathematical.

A few years ago, I came across a short article in the *New York Science Times* describing the differential ratios of three bad odors exhibited by male cockroaches. Having a lot of the really bad odor seemed to enhance dominance among other males, but having a small amount of the second-degree bad odor seemed to attract females. Why? The writer suggested that female cockroaches like a little bit of vulnerability in their males. This is good stuff. The writer's inference deals with current understandings of biological systems and their reliance on reproductive success. The cockroaches' "just right" odor ratio appears to influence their relationships!

I haven't thought about those cockroaches since I used the article with my class years ago. But I've thought a good deal about ratio and proportional reasoning, and I have used many other articles, experiments, devices, and materials in my quest to help students develop that reasoning. Developing the mental scheme to reason proportionally, applying that mental scheme to a variety of situations and circumstances, and ferreting out patterns within sets of data that may follow a proportional relationship are essential concepts that teachers might invite students to visit and revisit.

With one class, a teacher and students might spend some time hypothesizing what the cockroach odor ratios may be. With another class on that same day, the teacher and students

might spend time watching gears turn and establishing the gear ratio for different combinations of wheels. The key to helping students learn the concepts of ratio and proportion (the comparison of ratios) is to involve students in generating the numbers and generating the relationships among the numbers. The precise vehicle the teacher and students use to travel the road to understanding is secondary to the journey and its successful conclusion.

Instructional Practices That Reveal Gaps

Some people vehemently disagree with my line of reasoning. In a *Wall Street Journal* article a few years ago (Loveless, 1997), the author criticized a school district's decision to adopt policies that honor the nonstandard English speech patterns known as ebonics, and made the case that

Students think they know quite a bit, but they don't. This conflict between perception and reality emanates . . . from the same source as Oakland's misguided [pro-ebonics] policy, from an educational philosophy that—by blurring the boundaries separating knowing from not knowing—poses greater threats to the culture than the transgressions of street talk. (p. A14)

Loveless expresses the views of many, not only with regard to ways in which we learn to speak, but also to ways in which we learn mathematical computations, reading, and other academic processes. "Blurring the boundaries separating knowing from not knowing" makes a lot of people very uncomfortable. For example, some parents want teachers to log " $4 \times 3 = 12$ " into their child's memory and want teachers to discourage calculating methods that include counting by fours or counting by threes, grouping by five and adding two, and so forth. Some parents take no joy in seeing their young child derive answers by manipulating numbers in unique or multiple ways; instead, they view their child's lack of memorization as a missing element of the child's education.

I would argue that as a child matures, memorization

becomes a part of the child's facility with manipulating numbers and ability to recognize patterns quickly. Memorizing becomes an important tool to enhance subsequent learning. To press children to reach that place sooner has little lasting value (see Kamii & DeClark, 1985; Labinowicz & Labinowicz, 1985).

Hearing a child shout "Twelve!" immediately after a teacher asks for the product of four and three has an air of certainty and perfection that some people find rewarding and satisfying. But only by continuing beyond the memorization can a teacher begin to probe the child's thinking about number relationships, reveal the conceptual gaps in which teaching and learning can most productively occur, and move into the area of necessary uncertainty.

Contrary to the comfort that some seek in categories and distinctions, the lines between the realms of knowing and not knowing are very blurry indeed. It's when we recognize that the line is fuzzy that we're ready to learn. It's only when we realize how many unanswered questions we really have that we can search for understanding. The greater our exposure to the concepts embedded in the artistic, musical, literary, scientific, mathematical and otherwise beautifully complex world around us, the more often unanswered questions emerge.

Let's use science and mathematics concepts as examples. Can we define the elusive terms of energy and matter without using terms that have energy in their definitions? Does the history of plate tectonics provoke our intellectual skepticism of models and theories? Why do we think we know what we think we know? If we can predict the number of piano tuners in New York City with reasonable accuracy using simple arithmetic and probability measures, could we make predictions about atomic structure? Could the mechanisms by which bar codes route our letters to their destinations really have an analog in biological DNA processes?

These are the kind of questions that help reveal our conceptual gaps. These are the questions that, when incorporated in an instructional program, enhance a student's capacity to build ideas and cut new intellectual pathways.



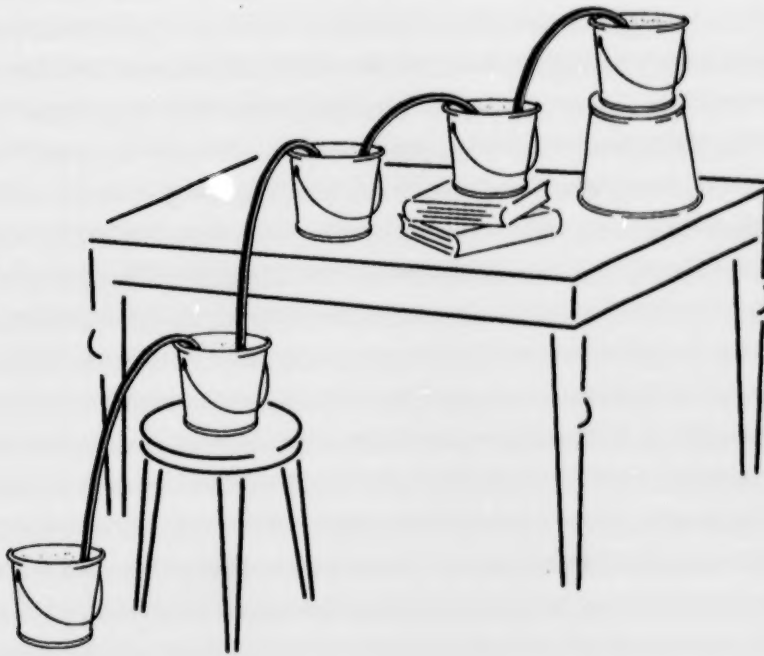
Back to the Heart of the Matter

THE LEARNING EPISODE IS AT THE HEART OF EDUCATION. In this chapter, we take a closer look at learning episodes and examine the genesis, the nature of the negotiation, and the embedded assessments that comprise the learning experience. The major actors in each learning episode are the teacher and the student, but the roles these actors play change dynamically as the episode evolves.

Let's begin by considering the example provided by Ms. Conrad and her student, David, in a 5th grade class working on a unit investigating water. David was trying to use aquarium tubing to siphon clean water from one bucket to another. As he was working, he looked up and saw a group of students at the next table who were trying to purify dirty water. David asked Ms. Conrad if he could work on that problem instead. His teacher replied that as soon as there were available materials, he was certainly free to do so.

"In the meantime," Ms. Conrad said, "Let me offer you a challenge. See if you can keep the water moving between your buckets for a total of three minutes. Here's a timer."

David and Ms. Conrad talked a little bit about where to hold the buckets, how to rig them up, and how to get the siphon going, and then Ms. Conrad moved on to help other students. By the time she returned to David, he had inverted a stray bucket to add height to the source water for the siphon, and had positioned the other buckets in a series of decreasing heights.



"You're an engineer," Ms. Conrad said. "You have a profession waiting for you."

"My uncle and my older brother are engineers," David replied.

"You can follow in their footsteps, then."

"I don't want to be an engineer," David told his teacher. "I want to be a cardiovascular surgeon."

"Well, we'd better get started right now," Ms. Conrad said, turning to retrieve a small bottle from the supply cabinet. "Let's add some red dye to the water because we need some blood. Okay. Now let's take a look at this tubing. Does it remind you of anything in the body that carries blood?"

"The aorta."

"The aorta is a big vessel that leaves the heart. What does the blood from the aorta flow into?"

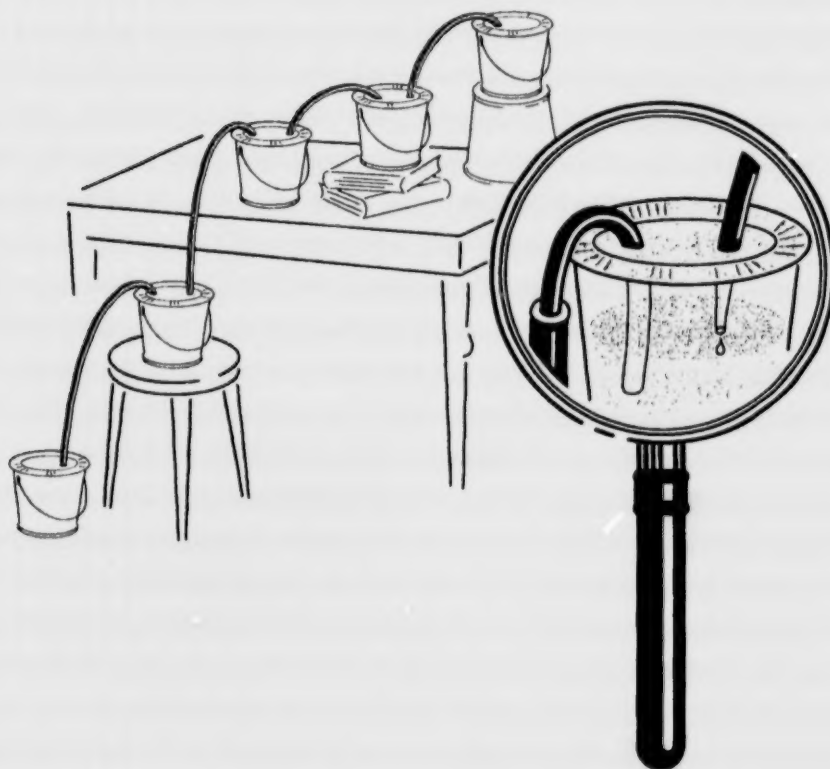
"I don't know."

"The vessels that bring blood from your heart to places in the body that need blood are called arteries. Do you know what the vessels that bring blood back to the heart are called?"

"No."

"They're called veins. A cardiovascular surgeon needs to know how to keep people's blood flowing through their system of blood vessels—vessels called arteries and veins and even smaller ones called capillaries. Maybe you could try to keep the blood flowing through these vessels for a total of three minutes. I'll be back."

And with that, Ms. Conrad continued on to her many other students. When she returned a second time, she saw that David had come up with a way to keep the water flowing for three minutes by slowing its rate of flow. David's solution involved removing the rubber tops of eyedroppers and inserting the small glass pipettes into the aquarium tubing. To keep the tubing in place, he had cut holes in paper plates, positioned the plates over the buckets, and threaded the flexible tubing through it.



David was beaming after an hour and a half's worth of work. He had designed, developed, and executed a plan—and his plan had worked.

Negotiating Curriculum

How might Ms. Conrad document the learning that occurred that morning? David evidenced the ability to measure time and volume, at least on the small scale of this activity. With his clamping and dismantled eyedropper setup, he showed success drawing some relationships between the aperture of a pipe and the speed and quantity of liquid flow in the pipe. With his paper plate-stabilization system, he showed an understanding of how to use opposing forces to create structural support.

Now that Ms. Conrad has learned something about David's concepts and skills, what role can she play in guiding David to the appropriate next steps? How can she help him reflect on his experiences in order to build new knowledge that he can transfer to other situations and refine further? Ms. Conrad might encourage David to write about and diagram his engineered water flow system. David might read about an urban water works or a rural irrigation system or diagram the pipe structure in his basement at home as a means to analyze the important features of his system and grapple with why it works. The fact that he created a model that works is only one piece of the much larger process of learning. This lesson is far from over. In fact, although David has conquered some very definite engineering challenges, he has yet to realize the most fruitful learning this activity can offer.

Ms. Conrad initially invited David to build an analogy to the human circulatory system, but as yet, we have no proof that he sees any relationship between blood flow through blood vessels and water flow through aquarium tubing. To determine the extent to which the tubing process informed David's thinking about the human circulatory system, Ms. Conrad will need

future interaction with him in which they seek to understand the similarities, as well as the differences, between the aquarium tubing and blood vessels.

The manner in which Ms. Conrad interacts with David provides a lens through which educators can look at learners. Her behaviors constitute an approach to the teaching/learning dynamic that is based on understandings of the learner as a unique constructor of knowledge. Ms. Conrad researches her student's thinking in order to tailor challenges to that thinking. She doesn't simply apply a model or program or recipe or checklist.

Ms. Conrad, herself, is also a unique constructor of knowledge. Her professional action requires logic and direction, but the logic and direction only unfold as she interacts with students. Thus, just as grading David's morning work using conventional systems might miss some very important learning, evaluating Ms. Conrad's effectiveness using conventional teacher-evaluation methods might miss some very important teaching. Did the teacher plan that David would spend an hour and a half setting up a series of buckets? No. Then why did it happen? It happened because Ms. Conrad saw a teachable moment, and she had the skill to manage it. Still, only a supervisor who appreciates flexibility and respects the role of the learner's perspective in the curriculum would value Ms. Conrad's teaching practice that day.

"The Tree from Brooklyn"

What are other examples of teaching and learning approaches that honor the processes of knowledge construction? Let's focus on a lesson that invites students to consider the elements of flight.

I have used the seedpods from the ailanthus tree in many lessons in different settings with learners of varying ages. The ailanthus is considered by some to be a "weed" tree, perhaps due to its invincibility in adverse conditions. Others refer to it as "the tree from heaven." The tree that sprouts through cracks in sidewalks and flourishes in vacant lots in Betty Smith's 1943 classic, *A Tree Grows in Brooklyn*, is an ailanthus.

By any name, the ailanthus has small seedpods that spin and tumble gracefully when released from a height. I often ask students to watch the flight path of these pods and model some aspect of the flight with common simple materials: paper, paper clips, glue, tape, and scissors.



Many students are completely baffled by this task. "What do you mean by 'model'?" they ask. "What do you want us to do?" For most, the hardest part is to choose only one aspect of the flight. They want to replicate all elements and end up with paper models that look identical to the natural pod. I often ask these students to tell me which features of the pod account for which aspects of its flight. The typical answer I get from students of all ages is, "It's complicated."

Parts and Wholes

The twin notions that we can begin to understand a complicated phenomenon by analyzing its parts, and that we can begin the process of coming to understand by determining which parts to analyze is . . . well . . . not well understood! Many of the adults I interact with in workshops, presentations, and conferences are quite perplexed as to how to begin. How can this be? So much of education involves analyzing the parts of

wholes. Why would that process be so difficult for students who have done so much "part analyzing"?

It's so difficult because most published curricula predetermine the parts of a topic or problem to be analyzed. And when the curriculum doesn't present the problem components, teachers often do. Therefore, the hardest part of the problem has already been solved for the students before they even begin. The end result is that students rarely get the opportunity to struggle with the difficult task of looking at a complex phenomenon and initiating steps to understand it. Without such opportunities, learning how to deal with the uncertainty and ambiguity embedded in all important real-life problems is minimized, rather than fostered.

Here's the good news: Presented with opportunities to analyze problems and create workable solutions, most students do. For the teacher, it's a matter of providing guidance appropriate to students' readiness. With some students, the teacher must overlay a good deal of structure and direction just to get them started on an inquiry. With other students, the teacher must help them fine-tune a technique. Sometimes, grouping together students who are using different experimental designs to explore similar concepts provokes good classroom discussion and knowledge construction. At other times, grouping together students who are using similar measures to investigate different variables prompts discourse that leads to learning.

As time and student inquiry progresses, various pieces of equipment and supplies make their way into the classroom for discussion and experimentation. The relevance of the problem emerges as a function of the match between the set of directions, prompts, or suggestions the teacher offers and the set of ideas, perspectives, and problems the students offer. The relevance of the learning emerges as students find their own problems, find their own voices in solving the problems they pose for themselves, and find satisfaction in their answers. As we discussed in Chapter 1, a life mentored by teachers who foster reflection and demand rigor can become a life governed by constantly evolving internal standards that press behavior and decision making to ever-increasing levels of excellence. This is a life with standards.

Curriculum with Embedded Assessment

So far in this chapter, we have looked at the ebb and flow of classroom interaction as it emerges through negotiation. Boomer, Lester, Onore, and Cook (1992) describe this sophisticated process of give and take:

There can never be exact congruence between what a teacher or a textbook means to mean and what a learner makes of that meaning. The dance between teacher and taught represents a continuing negotiation of meaning. Misunderstanding or rather partial understanding is inevitable but the quest to build progressively better mutual understandings is at the heart of teaching and learning. The teacher's key role is to ensure that learners do not learn to shut down their construing and reconstruing apparatus. (p. 279)

The extent to which classroom negotiation can occur, flourish, and produce new learning is dependent upon the initial questions or problems posed by the teacher or the learner. The following are some examples of initial curriculum invitations that have given rise to extensive and highly diverse student responses. This curriculum poses purposely ambiguous problems to students, problems that require students to recast original problems into more specific questions unique to each student or group. The teacher guides student research and assesses outcomes simultaneously. One process informs the other, as assessment is embedded within the curriculum. How students approach the problem is an indicator of prior knowledge. How students resolve the problem is an indicator of growth. Let's take a look at the curriculum, and then examine how one teacher and one student responded to one question.

Starting from Scratch

At the turn of the millennium, our increasingly computer-dependent society worried about the possible limitations of our relatively new computer systems. Was it possible that problems with date-keeping functions could shut down whole systems? Would the failure of computerized calendar programs prevent water from being pumped, electricity from being produced, or trucks from being dispatched? We spent millions of dollars to analyze, fix, replace, or back up systems that might be affected. We bought generators, stockpiled food, and set aside water.

During the height of Y2K preparation, my colleagues and I decided to invite our students to investigate what we would need to know if we did indeed have to "start from scratch." Here are seven different problem scenarios we posed to students:

1. *Communicating*

Our last ink pens have run dry and we don't have anything to use for writing. But we do have some soil and wax. Could we make our own crayons? How hot do we need to get the wax for it to melt? Does it always melt at the same temperature? How do we mix the soil and the wax to get the smoothest color crayon?

2. *Maintaining a Garden*

We have a garden on a hill and a pond below it. We want to use the pond to water the garden, but we've only seen water flow downhill. We could carry buckets of water up the hill, but is there an easier way? We have some siphoning tubes, an aquarium aerator, and materials to make water wheels and aqueducts. Will any of these items help us solve our problem?

3. *Feeding Ourselves*

Pasta is a comfort food for lots of people. Could we make our own? We have flour and water and eggs and olive oil. What proportions of these ingredients will produce a pasta dough that's not too sticky and not too dry? Once we've made the dough,

what size and shape should our pasta pieces be? We know we can use the pots of boiling water to cook the pasta, but there are so many of us that we can each have only five minutes of boiling time. Does the size of the pasta matter in how long it takes to cook?

4. Appreciating the Life Around Us

In *The Lion King*, Mufasa tells Simba that, in the end, we're all food for earthworms. Maybe we need to learn a little about earthworms to know what that means. We have some questions: What do earthworms like to eat? Do they prefer light or dark places? Can they swim? Can they hear? We have the earthworms, but asking them won't give us answers. How can we find out? What supplies do we need and what do we need to do with the supplies to find the answers to our questions?

5. Expressing Our Artistic Selves

We have some cloth we can use to make clothes, but the cloth is plain white and we like color. A friend told us that we could use vegetables to dye the cloth—orange from yams, red from beets, purple from purple cabbages, and green from spinach. But how do we go about doing that? Do we chop or grind the vegetables? Can we mix them with water? Does the temperature of the water make a difference? Another friend said that vinegar somehow helps. What does it do?

6. Keeping Our Property Clean

We found a huge collection of old pennies, but they're so grimy that the bank won't take them. (The bank tellers told us that the dirty pennies would jam the counting machine.) We need to clean the pennies, but we have no cleaning supplies—only some leftover items from the refrigerator and kitchen cabinet: ketchup, salt, oil, some lemons, vinegar, baking soda, and chili sauce. Will any of these items help solve the dirty penny problem?

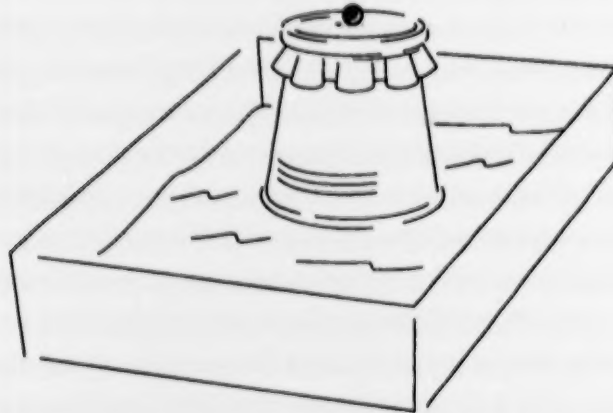
7. Learning About Other Ways to Grow Plants

We've heard of hydroponics, the science and art of growing plants without soil. The seeds and plants need some type of

support and a way to get the water and fertilizer that they need to grow. We have wicks and beads of varying sizes, cups, water, cheesecloth, and toothpicks. Using these materials (or other materials that you need and we can get for you), can you design a nurturing system for your plants? One major challenge to hydroponic gardeners is the wicking system that brings the water to the plants. We have three different types of wicks. Which is the best? How do you know? What is your proof?

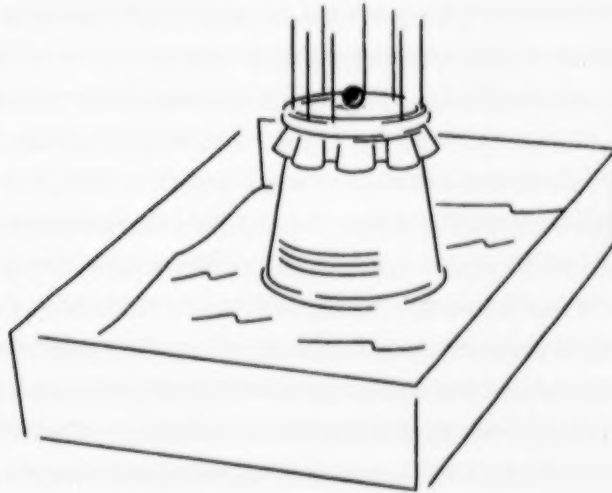
Thinking . . . and Assessing . . . for Oneself

Let's look at a student response to the hydroponics investigation. Mary, a 4th grader, cut a hole in the bottom of a small plastic cup, inserted a wick, inverted the cup, and placed a small piece of paper towel over what was now the top of the cup. She then secured the paper towel with an elastic band, placed the inverted cup in a shallow tray of water with the wick hanging down, and placed one pea seed on top of the paper towel.



Mary was pleased with her design, but was concerned that the seed would fall down upon germination. Her teacher, Ms. Grant, spying a box of toothpicks on the table, offered Mary the box as a potential problem-solver. "Would these help?" the teacher asked.

"Oh, I never even saw them there!" Mary exclaimed. Mary eagerly accepted the toothpicks and readily constructed a fence of toothpicks along the circumference of the cup to support the pea plant as it grew.



Having solved the wicking problem to her satisfaction, Mary posed a structural problem. Ms. Grant could have "solved" Mary's problem by telling her that the design was top-heavy, inefficient, and out of scale with the potential size of the mature plant. But Ms. Grant, valuing her student's viewpoint, helped Mary solve the problem Mary identified for herself. At that moment, Mary was concerned about scale in terms of the seedling state. If the child were to identify a scale problem with the mature plant in the future, Ms. Grant would be ready. For that moment, however, Ms. Grant did not try to address a problem that was not a problem for the child.

It Takes a Child

The resolution of Mary's hydroponic gardening problem is just one example of how it takes a child to give meaning to a

teacher's actions. Ms. Grant viewed the problem through the lens of Mary's thinking and offered a response that she thought would take that thinking forward. But to understand the teaching/learning dynamic, we must also understand what Ms. Grant was thinking as she did this. How do professionals think in action?

Donald Schön (1983) has studied this process of professional thinking and describes different perspectives. There's the technical rationality view of professional activity that characterizes it as a rigorous and systematic application of scientific theory and technique. Then, there's "reflection-in-action," a view of professional activity that recognizes tacit knowledge and judgment as integral to situations of uncertainty and value conflict. Although these views are different, they share a similar problem. The "technical experts" view admission of uncertainty as a sign of weakness and a threat. Likewise, the "reflective practitioners" view an inability to articulate their problem-solving processes with uneasiness:

The dilemma of rigor or relevance may be dissolved if we can develop an epistemology of practice which places technical problem solving within a broader context of reflective inquiry, shows how reflection-in-action may be rigorous in its own right, and links the art of practice in uncertainty and uniqueness to the scientist's art of research. (Schön, 1983, p. 69)

The reflection-in-action model accounts for both our readiness and ability to discover meaning in what we do and our ability to gain understanding from thinking about what we do. For teachers, the learning standards published in each state become one filter through which to determine appropriate professional action. One's own internal standards and a host of other variables form other filters. The value of the teacher's professional action rests on many delicate points—the balance of which is determined by the learner's response. A career of making meaning becomes a teacher's professional portfolio.

The apparently nebulous field of education is not the only one that embodies so much uncertainty and requires so much

reflection. Schön (1983) has identified the professions of psychotherapy, town planning, engineering, architecture, and business management as others requiring a good deal of reflection-in-action. Let's consider how the practice of orthodontia can also fit this scheme.

Like teaching, orthodontia can be practiced as a set of clear-cut procedures, analogous to the clear-cut yet limited practices described in Part II of this book. But again, like teaching, orthodontia can also be a delicate negotiation requiring unique decisions and contextual collaborations. Let's shadow Dr. Klempner and his staff, who believe it is important that young patients become active players in their own orthodontic treatment. What does a constructivist philosophy look like in an orthodontia practice?

When 7-year-old Jody and her mom came in for a diagnostic visit, Gail, the office facilitator, met them in the welcoming room and introduced them to the office setting. There were fish to feed, basketballs to be dunked into hoops, games to be played, and lots of pictures of smiling children to view. Jody chose to feed the fish as Gail listened to her concerns and explained procedures. When Dr. Klempner met Jody, he described what he was doing, why he was doing it, and what he was thinking about as he examined her. With eye contact primarily with Jody, Dr. Klempner described the treatment options, and then the doctor, parent, and child discussed the feasibility of each option before settling on a plan that each could endorse and support. According to the doctor, the office rule is never to embark on a plan that can't be supported. Treatment must be connected to the here and now.

Working together, Gail and Jody prepared the compound they would use to take an impression of Jody's mouth. Jody inserted some of the compound in her mouth to get used to the texture and sensation before Gail filled the mold and held the mold in Jody's mouth for the required setting time. When it was time to take pictures of the intra-oral cavity, Jody held the tiny camera herself and watched her own explorations on the monitor set up in front of her. She wanted to look at the freckles on her cheek, and Gail showed equally great interest in seeing what they would look like magnified on the monitor.

They both were surprised by the irregular edges of each freckle, and Gail printed out a copy of the freckle photo along with the pictures she needed for Jody's official records.

Jody's treatment involved the installation of twin block expansion plates, two devices designed to widen the palette and move the lower jaw forward. These twin block expansion plates can make eating a challenging experience. Gail didn't tell Jody to "get used to" this peculiar apparatus in her mouth; instead, they sat down to a meal together. Jody described the troubles she was having, and Gail offered suggestions to help Jody find her own way to achieve some temporary comfort with the appliance. After their trial lunch, Gail helped Jody enter her own next appointment on the scheduling computer. Jody went home knowing that if she experienced a problem, it was her job to let the right people know.

This kind of constructivist-based orthodontic practice may sound to some like a slow process that requires extra staff and costs more money. Many people surmise the same about constructivist teaching environments that seek to elicit the learner's perspective or spend time asking the learner to puzzle out problems the teacher could easily solve. But the value of the time devoted to helping children seize ownership of their own school learning (or their own orthodontia treatment) is evidenced repeatedly in life—in the shorter periods of time it takes them to solve problems; in their ability to apply to new situations processes they're integrated into their thinking; and in fewer relapses of progress (Reimann & Spada, 1995).

Educational processes that focus professional time on the learner's investment in the learning process do not require extra people. They require that people work differently, interact differently, and spend their time differently. The payoff from this investment is learning that lasts.



Beginning with Understanding in Mind

SHIFTING ONE'S THINKING ON ANY TOPIC IS HARD TO DO. Change often involves giving up something. As we have discussed, cognitive growth and learning sometimes involve adding new ideas or stretching old ideas. But often they involve *replacing* ideas: replacing one set of ideas with deeper, richer, more inclusive ones. Replacing our old images and conceptions of what "a good school" is—and what its aims, outcomes, and methods are—with new images of a good school appears to be a particularly difficult task, perhaps made more difficult due to the emotional importance of our own childhood memories of school.

By the general terms, phrases, and questions we utter, we often position schools as places in which the students serve the teachers. "How many pages did the teacher say the paper needs to be?" "When did the teacher say the paper is due?" "My teacher won't accept it unless the date is in the upper left hand corner." In this chapter, we consider schools from a different viewpoint, one in which each learner is a client and the school is the agency charged with serving these clients. From this perspective, a good school is one in which school personnel know where the learning exchanges are heading and know where the beginning point of instruction is now. They meet each learner at the learner's leading edge in order to achieve their negotiated aims. To reserve judgment of that leading edge is yet another difficult yet imperative task. What the student "should" know setting out is irrelevant; it's what the student *does* know that's important to assess.

Let's look at some examples of how teachers begin with educational aims in mind but determine teaching practices and make curriculum choices as a function of their ongoing interaction with learners.

Broken Compasses

One day, in one of our teaching labs in the Science Education Program at Stony Brook University, an intern handed me an inexpensive navigational compass he was using in a lesson and told me it was broken. I figured that the needle in the compass must have dislodged from the pin, and I casually discarded the small, broken compass. As the unit of study continued, another intern brought me another broken compass. I set it aside.

During the next few weeks, my broken compass pile continued to grow. It was time to investigate. Granted, if I stood very close to the computer, there was interference that affected the reading. And with some compasses, the red end of the needle pointed north, while on others, it was the blue end that pointed north. But generally, the compasses appeared quite functional to me.

Over time, I began to realize that many of the teaching interns and a majority of the 3rd to 12th graders who visited the lab during this unit of study had never learned to use a compass to find geographic headings. My colleagues and I decided that giving our learners (interns and students) the opportunity to make their own compasses might be a useful enterprise.

Where to begin? At first we thought about giving our learners magnets and some thread and asking them to create a compass using these materials and their knowledge about magnetic poles. For the interns, who could recollect prior experiences and reflections on the properties of magnets, this task was appropriate, but not easy. For the young students, however, it was premature. Unless they understood something about the properties of the small magnets, the idea that we can use a magnet as a compass because our planet is one giant magnet would have less impact. Our solution was to invite the

young students to design their own experiments to determine if different magnets have different strengths.

The teacher's role at the beginning of the lesson was to guide students in the design of their experiments. Measuring magnet strength incorporates many sophisticated concepts; therefore, the teacher had to be careful to give guidance that was appropriate to the students' responses.

Consider a familiar experimental design incorporated in many elementary school curricula: using paper clips as a test of magnet strength. The greater the number of paper clips a magnet can hold, the greater the magnet's strength. Within the teaching/learning episode, the teacher must be able to establish that the students who use paper clips in their experimental design do, indeed, view the paper clips as a proxy measurement for magnet strength. If the students cannot articulate that relationship, guiding the students to use those materials is little more than an example of fostering student compliance.

The teacher's professional judgment is critical for determining next steps. Some students may suggest that putting their magnets on top of iron filings encased in plastic and observing the patterns of filings may be a way to measure strength. These students may have "accidentally" discovered the force fields generated from putting a magnet on the iron/plastic material that the teacher "accidentally" placed around the room. The teacher's role is to elicit the underlying thinking behind the students' actions and decisions.

Once the students have experimented with magnetic forces in relationship to other magnets, the next appropriate step might be for the teacher to introduce Earth as one very large magnet, with two poles (north and south) that share the same characteristics as the small magnets being studied in the classroom. Some students may ask, as they did in our teaching lab, if their small magnets will orient themselves along Earth's north/south alignment. In our lab, we asked students to design an experiment to generate an answer to this question. At this point, technological challenges often emerged, such as how freely the magnet must be able to move without being handled. The students rigged up their designs and several had their small rectangular magnets aligned with each other. They concluded

that they had found the north/south alignment, and they were most pleased . . . but not finished.

The lesson got difficult again. The students had no ready way of distinguishing north from south. The instructors focused classroom discussion on the variables that could be useful in helping solve the problem. Students contributed data they thought would be helpful. One child knew that moss grows on the north side of trees. Could we go outside and look for moss? Several knew that "the sun rises in the east and sets in the west." Would knowing what time it is help us determine east and west, and then north and south? Perhaps. This compass lesson wasn't quick, and it wasn't easy!

Compasses are often used as references in many larger topics, such as making and reading maps, navigating and orienteering, and deciphering the geometry of circles or angle measurements. For a reference to a compass to be useful in building new understandings, concepts integral to understanding the compass itself must be well established. Otherwise, mere head nodding occurs, with the reference to the compass offering no greater access route to the new concept.

The type of classroom environment just described uses student performance as an assessment of student understanding. For a lesson like this one, students might keep individual portfolios to track their experimental design, their "theory" construction along the course of the lesson, the equipment and supplies they use, their study partners, and so forth. These documents serve not only as guides to assess the students' present thinking and skills, but also as diagnostic tools for the future when new studies are under way and the students are documenting new learning in the context of what they recollect from past investigations.

Opening Eyes

Many people say that constructivist-based educational opportunities are unnecessary, impractical, or impossible in most

schools. A peek into a series of classrooms will illustrate how and why these practices are necessary, practical, and possible.

Chemistry Class

Ms. Lilly had a question for her chemistry students: What does a water filter filter out and how does it do it? She showed the class the supplies available for their investigation of this question: microscopes, a water mixture with bacteria and chlorine, and two kinds of filters (carbon resin-based filters and micropore filters).

Ms. Lilly's highly prescribed chemistry syllabus stipulates that students learn two essential concepts:

1. A water mixture with impurities can be made pure through physical changes that separate the impurities of the water mixture while keeping the original forms of the water and the impurities intact.

2. A water mixture with impurities can be made pure through chemical changes that separate the water and the impurities by creating new compounds that are removed from the water.

Ms. Lilly could have covered this part of the syllabus with a vocabulary list of important words, followed by assigned sections from the chemistry textbook. She could have instructed the students to copy down a definition of "physical change" and a definition of "chemical change" from the chalkboard or a PowerPoint slide. She could have reviewed the concepts by asking the students to put the vocabulary words on flash cards and could have assessed student mastery of the words through a vocabulary test. But she didn't.

Ms. Lilly chose a different route. She presented a question and gathered initial supplies and equipment that might help the students answer the question. She wanted her students to analyze a water sample under a microscope before and after it was poured through a micropore filter and then reflect upon the differences so that they might establish an initial working definition of a physical change. Reading the thinking of others who have performed such experiments can add to a student's understanding. Working with the same idea with

different materials can help consolidate a student's conceptualizations.

Ironically—or maybe not so ironically—in their search for an answer to Ms. Lilly's question, some students went immediately to the textbook and read the same sections that another chemistry teacher might have assigned. Others started their own vocabulary lists. Others copied definitions into their notebooks. Still others immediately begin formulating an experimental design.

Ms. Lilly's approach provoked her students to reach out and seize their own education. Her students required different types of invitations to do so. She wanted to make it easy for students to accept the invitation; but she didn't want to make it easy for students to get their education.

Physics Class

Mr. Dubois began a physics lesson by showing posters of Gothic architecture from the Middle Ages—structures that were taller and had thinner walls than any buildings previously constructed. He also displayed posters of the thicker-walled, columned structures characteristic of Roman architecture. Architecture in physics class? What was Mr. Dubois's purpose in showing these pictures?

The essential concept Mr. Dubois wanted his students to explore was that forces can counterbalance each other. The pointed arches of Gothic architecture direct weight diagonally away from the arch. The remainder of the lesson was devoted to proving that contention.

Mr. Dubois proceeded to answer some students' questions and refer other students to additional sources. He asked Rachel to find a particular painting on the Internet and told Jordan that there was a particular book in the library that could address his question. Mr. Dubois didn't come to class that morning with an evening's worth of preparation for this lesson; he came with a lifetime's worth. He guided the students' learning experiences based on his expertise in the subject area, his pedagogical sophistication, and his ability to hear what his students were telling him. Knowing that he planned

to introduce counterbalancing forces in other domains in subsequent lessons, Mr. Dubois also searched for segues into those investigations that emerged from student responses.

Earth Science Class

Students in Ms. Stein's earth science class examined various crystal samples, drew the crystals' geometric forms as they saw them, and superimposed the lines of symmetry they found in the various samples. What was the purpose behind this activity?

The essential concept Ms. Stein wanted her students to understand was that the faces that describe a crystal's external habit are a direct consequence of its internal structure. Ms. Stein knows that the atoms, ions, or molecules that make up a mineral occupy symmetrically arranged positions in space that mimic the symmetry of the crystal structure visible to the eye.

The lesson continued over a few days. When students finished diagramming the samples, they analyzed diagrams of each crystal's atom arrangement and searched for relationships. Ms. Stein was quite willing to allow this lesson to continue, giving students a chance to diagram multiple crystal structures and look at diagrams of atomic structures. Yes, the course had a packed syllabus, and yes, there were state-level exams for students to take at the end of the year. But Ms. Stein knew that if students didn't grasp the big idea that the characteristic shapes of the crystals are windows into the characteristic arrangement of atoms, they would have difficulty learning more complex concepts. She knew the value of the time invested in this investigation would repay itself many times over in learning situations to come.

Biology Class

Mr. Mykos began class by asking his biology students, "What do a herd of oxen, your own skin, a cell membrane, tree bark, and Earth's atmosphere all have in common?"

The essential idea that Mr. Mykos wrote in his plan book was that life needs an inside and an outside—a protective barrier that creates an inner environment and an outer environment

and has embedded "pumps" to move materials in and waste out, allowing the metabolic processes on which life depends to work. Seeking answers to their teacher's cryptic question, Mr. Mykos's students spent several class periods studying the specific molecules of the cell membranes, the regulatory systems of skin, and the behaviors of communities of organisms through the lens of one of the key organizing principles of biology: There is a difference between in and out.

Examining this one simple-sounding statement as a perspective from which to look at many biological processes and phenomena can take students through multiple levels of sophistication and specificity. This is what makes a "big idea" big: overarching principles that meander through many topics and are applicable in diverse settings.

Finding Common Ground for Learning

In schools everywhere, there are home and career teachers teaching students how to make biscuits—and many of these teachers have never thought of discussing the acid/base reactions that make biscuits rise. In schools everywhere, there are science teachers discussing acid/base reactions, many of whom have never thought of using biscuit-making to explore the embedded concepts. To students and to members of the general public, it might seem that these sets of teachers have very different jobs. The teachers might agree with that assessment.

But let's look at this from a different point of view. The intent of both the science teachers and the home and career teachers is to enhance their students' ability to pose questions and solve problems. If we conceptualize the role of these teachers not as delivering specific lessons on certain topics, but as mentoring their students in problem finding and problem solving, we see that there are teachable moments everywhere—and, from this perspective, the universal components of these teachers' roles become apparent.

Making Biscuits/Studying Bases

Every science class needs a kitchen and writing groups, and every home and careers class needs science and math resources. Consider the following cross-curriculum challenge:

Last night, we wanted to make a batch of biscuits. We had all the ingredients listed in the recipe, except for baking soda. We made a special trip to the supermarket, got the missing ingredient, and followed the recipe. But all day we've been wondering: Does a half teaspoon of baking soda really make a difference? Let's design an experiment to find out. In addition, because our ovens are small, please halve the recipe.

Ingredients

1 cup flour	$\frac{1}{2}$ teaspoon cornstarch
$\frac{1}{2}$ teaspoon salt	1 teaspoon cream of tartar
$\frac{1}{2}$ teaspoon baking soda	$\frac{1}{4}$ cup shortening
	$\frac{1}{2}$ cup milk

Directions

- Sift together the dry ingredients.
- Cut in the shortening.
- Add the milk all at once and mix.
- Form the biscuits and bake them in a 450°F oven until golden brown.

I have made many biscuits with many students of many ages, typically after presenting a scenario and question similar to the preceding challenge. We usually begin by discussing the problem and talking about the kind of evidence we'll need to determine if baking soda really makes a difference. What students accept or reject as convincing evidence tells me much about their thinking. Next, we decide on experimental designs, often agreeing to proceed differently so that different groups of students can pool their data. Some students suggest leaving out the milk or leaving out the shortening along with leaving out the baking soda. Those suggestions become fertile opportunities to explore the concept of experimental controls.

You may have noticed that the biscuit recipe does not prescribe a specific baking time, noting only that the biscuits should bake until they are golden brown. As some batches of

biscuits turn golden well before other batches, some students bring up the issue of experimental design: Is it better to keep all batches in the oven for the same amount of time or to the same degree of doneness? Some students conclude that we must bake all batches the same number of minutes. Others use their initial observations to conclude it is more logical to bake the biscuits to the same level of golden brown, varying the time as necessary. These concerns reveal the importance of documentation, consensus building, variable analysis, and other issues relevant across disciplines. The size of the biscuit then emerges as a factor to consider, leading to many mathematical issues and skills. And the lessons go on.

Once the class comes to their conclusions, whether these are in the form of an answer to an agreed-upon question, charts of critical values and parameters, or narratives, the *why* and the *how* become important inquiries. Considering why baking soda is important in biscuit making and how it affects the biscuits' outcome is essential to extending students' understandings of their experimental findings. If teachers do not take the lesson into this arena (albeit on a level of specificity appropriate to the ages and stages of the students) they miss too many important learning opportunities with transfer potential to too many other learning opportunities.

Exploring the How and Why

Teachers who situate the purpose and potential applications of class work into meaningful problems help students find significance at junctions all along the learning and schooling pathways.

"Just show me what to do." That's what most people say, either out loud with words or silently with actions, when they're asked to solve a problem with many pieces. Many people expect that others have already solved the problem. When I ask others "What is important to learn in school?" most of those I've queried ask me a question in return: "Isn't the curriculum already decided?" When I ask them, "How do teachers know what their students are learning?" they quizzically respond, "Don't they just give a test?" And to the question, "How do you know

how to teach something to someone?" most respond, "Don't you just start at the beginning?"

Maybe. If you can find it. Sometimes the beginning is hard to spot. And sometimes, when found, it isn't the best place to start. Sometimes jumping into a real problem already in progress teaches us more. Think of a novel that opens in the middle of a scene. As the reader, you begin on the first page to deduce the relationships among characters who "existed" long before the moment you joined them. You're engaged. You want to find out more.

In this chapter, we have examined several curriculum examples selected to illustrate the nature of curriculum designed to draw out students' emerging understandings of essential concepts. Once those emerging understandings are brought to light, the teacher helps the student develop them into deeper understandings.

Today's schools serve students of very diverse backgrounds, all with unique personal histories. Teachers must grapple with the dilemmas of how to teach and then how to acknowledge student growth and achievement that is as diverse as the students' original starting points. The examples in this chapter and throughout the book are the types of curriculum invitations that create a common ground—a place from which students have access to multiple entry points as well as multiple exit points. Students of diverse experiences with varying levels of prior knowledge can all participate in these explorations. When students and teachers begin with *understanding* in mind, they extend their investigations into many related areas while still maintaining focus on the curricular concept under scrutiny. Both teachers and students start off any new learning with one kind of understanding and move toward another as they seek answers.



Old Issues, New Images

THE EDUCATION I DESCRIBE AND ADVOCATE IN THIS BOOK IS A constructivist education. I have purposively used the term sparingly with the hope that the stories could tell themselves without being classified before they unfolded. When I have been invited to make presentations, often the organizer has quietly requested that I omit the word "constructivism." I have been told that board of education members believe their students will score poorly on tests if teachers use constructivist teaching practices. I have been told that teachers will think the workshop is impractical if the word "constructivism" is used. I have been told that parents will get nervous, administrators will be bored, and in general, everyone will be confused if that nefarious word is spoken.

In response to this predicted confusion, I ask, "What's wrong with confusion?" Being confused is the necessary beginning for great learning. If you're not confused about something, where is the spur to investigate it? And what's wrong with a teacher-workshop that's not purely practical? Ideally, sophisticated professional development helps teachers situate practical activities into a framework that allows them to learn something new about pedagogy. Then, out of this new learning, teachers can create their own practical activities. Attending a workshop to increase the number of items on one's activity list does nothing to refine one's curriculum or syllabus or plan of study. Becoming a more sophisticated teacher is like any other learning: It's not an additive process, but an iterative one in which more complex understandings of intellectual growth

and development replace less complex ones through a systematic process of revisiting key concepts.

What of the worry that administrators will be bored? If administrative decisions are not tied to theories of learning, then the school in which those decisions are being made has no vision. And nervous parents? What parents *aren't* nervous about the future of their children—those beings in the world whom they love so very much?

We need to ask ourselves several questions. When did we decide we wanted to minimize community conversation about educational visions? When did we decide we wanted to create staff development opportunities that are neat, entertaining packages most notable for their take-home goodies? When did we come to accept the image of teachers as mere implementers of state curricula? When did we come to accept the image of schools as places in which no one has to think too hard? It's time we got back to the tough questions. I'm reminded of an observation made by Postman (1996):

There is no intellectual activity more American than quarrelling about what education means, especially within the context of school. Americans rely on their schools, even more than on their courts, to express their vision of who they are, which is why they are usually arguing over what happens in schools. (p. 139)

Tough Questions, Evolving Answers

In the field of education, we operate every day by asking complex questions and proceeding according to answers that are developing, not definite. The questions are significant: How is learning self-regulated? What is knowledge? How can educators facilitate knowledge production? Is there an objective truth that we struggle to know, or are there different truths dependent on perception? These essential questions generate very

diverse answers. For the constructivist educator, amid this array of widely varied responses is the cohesive notion that learners generate meaning through spiraling mental processes that satisfy the search for understanding. The more we learn about our learners and learning processes, the better we can design learning settings. But, given the complexity of human beings and the further complexities of many human beings interacting together, the educational settings we create will always be evolving.

As answers to these questions evolve and as teaching practices change, critics say educators are following fads. I don't necessarily see it that way. Consider the ubiquitous "big books," those oversized paperbacks popular for some time in primary school group reading activities. If a school orders big books because its reading specialist saw them at a national conference and thinks it timely that the school's 1st grade teachers use them, the school might very well be participating in a fad. But if a teacher buys big books and their common-sized versions in order to facilitate children's emergent skills of decoding, searching for textual patterns, and interpreting meaning, the teacher is more likely grappling with the complex, constructivist theories of early literacy development than pursuing a fad.

Paulo Freire, in his famous works *Pedagogy of the Oppressed* (1970) and *Pedagogy of Hope* (1995), writes of the need to situate literacy development in opportunities for empowerment. Without helping learners pursue new levels of awareness of their worlds and without challenging learners to change that which they perceive as unjust, contradictory, or otherwise unsettling, education merely helps learners bank information.

Although not all educational theorists would categorize Freire's ideas as constructivist, Baines and Stanley (2000) refer to constructivism, in general, as a "rage against expertise" (p. 327) and interpret Freire's theories as

Substantiation for fostering ideals of empowerment in lieu of teaching content. . . . Imagine a teacher consulting such advice in the process of formulating a plan for teaching physics first period on Monday morning. (p. 328)

No need to imagine that teacher! I explore physical science principles with students of many ages, and when formulating my plans, I most decidedly refer to the perspective that Baines and Stanley dismiss. If my students are to develop deep understandings of any physical science principles, I know they must design experiments, document data, replicate data, consult resources, and communicate findings. This is a social as well as an individual process. To gain support for their ideas, students must experiment and communicate within the traditions of acceptable protocols. These protocols are the "rules of the road" determined in prior times by scientists with power and influence. Sometimes, students make a case for breaking away from those protocols. Sometimes, scientists with power and influence make a case for breaking away from those protocols. These times of intellectual rebellion are troublesome at the moment, but they cut new paths that transform our collective consciousness.

Empowerment is rooted in knowledge. It is impossible to foster student empowerment without guiding student knowledge construction. Constructivism is not a rage against expertise. It is a call *for* expertise by people who understand the *processes* that occur on the intellectual pathway *to* expertise.

Active Processes of Meaning Making

Expertise emerges from meaning making and skill development. The cognitive processes involved in making meaning are active ones that require learners to continually evaluate new information and experiences against their current theories, rules, and notions. This viewpoint stands in stark contrast to other assertions that learners' minds are clean slates ready for inscription through a model such as direct teaching. Constructivism states that learners approach new experiences with a set of pre-established beliefs and naïve theories. Learners change those beliefs and theories only when they cannot reconcile new data with presently held conceptions. Within this broadly defined study of constructivism, the work of a number of well-regarded theorists and researchers contributes to our current conceptions of good educational practice.

Dewey (1913) helps to focus our attention on the teacher as a facilitator—a facilitator of environments in which learners continually collect and evaluate information and test new knowledge. In Dewey's view, meritorious school activities must include individual action, consequences of action, and reflectivity, with the level of reflectivity increasing as the actions become more sophisticated. Vygotsky (1962/1986) directs our attention to the teacher as a mentor, one who performs more framing functions for the learner than does Dewey's facilitator.

Neither Dewey nor Vygotsky would be likely to consider a student's ability to recite the names of the three branches of the United States government an educational gain in and of itself. However, both might find educational merit in learners figuring out how and why a single U. S. senator's change in political party affiliation might affect the presiding president's political success. For Vygotsky, such an educational gain might also indicate other important learning: for example, that governance in the United States is determined by a system of interrelating branches, and the simpler idea that each branch has a name. For Dewey, related important learning might include the notion that an individual questioning the status quo can be a powerful agent of change. The motivation to engage in any activity at all is the learner's individual interest in solving a problem, in this case, how one action by a well-regarded but previously not too widely known senator could result in widespread changes all over the national political landscape. As Glassman (2001) notes

Both Vygotsky and Dewey see inquiry as progressive problem solving. The individual is forced to confront issues that are not easily reconciled by current thinking. Interest is the only true motivation that can force this type of confrontation, pushing the mind from comfort into conflict. (p. 10)

“Good for the Gifted”

Many people believe that this type of education—one that carefully considers the learner's thinking or is based on progressive

problem solving—is good only for gifted students or is possible only in the privileged enclaves of private schools. This type of education does work in these settings, but it also works with children in the mainstream in public schools.

Some readers may contend that it's unrealistic to base the practices of public schools crammed full of hundreds, often thousands, of students on a pedagogy that seeks first to unveil students' present conceptions of new topics. Yes, there are many restraints within our current system that make good education difficult to offer. And that's why we need to change our current system. We can continue to teach the way we do now and lament that students learn only for the test, which they do. Or we can change the way we teach and lament the subsequent problems that such changes will provoke, which, indeed, they will. Or we can change the way we teach—and savor the rebellion.

The Rebellion

Any rebellion requires many players, all with different parts. I live on a little peninsula on the East Coast of the United States, an area rich in Revolutionary War history. Here, in the 1770s, a small band of residents formed a spy ring that passed information about the British army's activities in New York City across Long Island Sound and through Connecticut to General George Washington, headquartered in New Jersey. Anna Strong signaled the arrival of Caleb Brewster in his whaleboat by hanging a black petticoat on her laundry line. Aaron Woodhull would see the petticoat across Little Bay, then secretly meet Brewster along the shoreline after dark to exchange information. How Anna Strong knew of Brewster's arrival is unknown, but local accounts suggest that Strong got her information from her children, who played in the fields overlooking Setauket Harbor and, beyond that, Long Island Sound.

The people in this history (innovative and organized), and the physical setting (flat land and uninterrupted lines of sight), together and in conjunction with many other factors and actors, played a part in bringing about monumental change: a new, sovereign nation. What about the schools we have today?

Can they, too, become lands of sovereignty? I believe they can. But who are the people who can change our images of schools? Out of which settings can those images emerge? Freeing our schools from their conventional academic trappings so that they may become intellectually open requires community wisdom. In the words of Harold Berlak (2001)

Significant school reform is not possible without significant reform of the current system of national and state educational assessments. Change will come about only in response to pressure by coalitions and alliances that cut across political, social class, racial and ideological lines. (p. 11)

Structure and Efficiency

Concerns over structure and efficiency underlie most of the current assessments, guidelines, rules, and regulations that govern school and classroom operations. Let's investigate these two issues, which factor prominently in the decisions schools and communities make regarding educational policies and budgets and the decisions the teachers within these schools and communities make as they try to educate the young.

As teachers, administrators, and parents attempt to understand the transformation of constructivist learning theory into classroom life, they ask the same questions, whether they are advocates, dissenters, or skeptics of the constructivist learning theory. They ask, "How can teachers possibly maintain a structured learning environment if students spend so much time designing their own investigations and teachers spend so much time mediating those various investigations? How can students remain focused, on task, and learning?" They often conclude, "I can't imagine there could be enough structure."

Structure in the constructivist classroom can differ from the typical educational conception of the term. Typically, "structure" conjures up images of desks in a row, homework

submitted in neat piles, and quizzes every Friday. In a constructivist classroom, structure may mean desks set up for the unique needs of the upcoming event, homework submitted for critique by peers and used to inform upcoming learning opportunities, and presentations of learning when the students have generated a product they are ready to share. Structure in the constructivist classroom is based on principles of learning. The teacher establishes norms, procedures, and policies, and then negotiates them with students in ways that could easily go unnoticed by the novice eye.

Structure in Principles

In Ms. Jefferson's 6th grade class, for example, students move about the classroom freely to get supplies, meet with members of their study groups, confer with the teacher, or return to work started at an earlier point. Are the students moving about purposefully, and does this freedom have any effect on their conceptual change and their eventual learning? Only careful analysis and documentation can answer that question. In this classroom, the students' chance to be self-directed exists, but the chance to *not* be self-directed also exists. However, if Ms. Jefferson does not offer her students freedom, she ties her own diagnostic hands and deprives students of important learning opportunities.

For instance, one day, during a lesson exploring geometric shapes, Ms. Jefferson noticed that a group of students sitting next to an open window seemed uncomfortably cold. Within the context of this math lesson, she introduced questions about self-responsibility and prosocial action. Could the students concentrate on the topic of geometric shapes if they were so cold their bodies were shivering? Whose job was it to keep the classroom comfortable enough to work in? Ms. Jefferson and her class brainstormed ways in which each of them might respectfully change the environment to make it personally comfortable without violating the rights of other students.

When she noticed the shivering students, Ms. Jefferson could have simply instructed one of them to close the window or all of them to move to different seats, but she refrained

from making their problem her problem. Instead, she made their problem her opportunity to explore with them options for solving not only the current problem of the open window, but perhaps similar future problems involving personal responsibility and positive social action.

Was Ms. Jefferson off task? In the middle of a math lesson, she employed cold breezes from an open window to frame a class discussion. When I analyze the structure Ms. Jefferson created in her class, I conclude that she was not off task. Maintaining the classroom as a comfortable learning environment for everyone, promoting ownership of classroom space, and encouraging students to be forthcoming when they cannot concentrate on the academic program is the way in which Ms. Jefferson engenders civic appreciation, protects equality, and minimizes the likelihood of bullying, graffiti, and disrespect. Ms. Jefferson doesn't use packaged "self-esteem" programs with talking bears that tell children they are wonderful. She doesn't use gold stars on classroom charts for children "caught being good." She doesn't hand out word searches with adjectives such as "caring" and "kind." The structure of her classroom follows a different pedagogy. To see the structure requires an interpretive eye.

Structure in Context

On another day, visitors to Ms. Jefferson's class would have found her encouraging a group of students to share their interpretations of characters in a book they were reading. Or they would have found her instructing a group of students on the conventional format of business letters. In these two cases, the structure of small-group meetings with the teacher looked similar, but the teacher's instructional objectives and the students' opportunities to change their current perspectives were very different.

In the character interpretation lesson, Ms. Jefferson's objective was to invite students to explore the power of evidence in engendering support for a unique perspective. She guided students back to the text, asking them to reread the portions of the book that made them think the way they did.

Who picked the book and why, and who picked the character interpretation lesson and why are important questions to be answered *before* a visitor to Ms. Jefferson's class will be able to form a deep understanding of the teacher's instructional objectives and the students' learning opportunities. In this case, several weeks earlier Ms. Jefferson had chosen a children's picture book with a theme she thought might resonate with the students—the theme of change. During a discussion of that book, the students had recalled books and poems and short stories with similar or opposite themes. Ms. Jefferson asked each student mentioning a new piece of literature to assume a leadership role in exploring that piece with members of the class. The literature the students were exploring in the "observed" lesson was a book so enthusiastically endorsed by one of the class members that all the students wanted to read it. That history would not have been evident through a one-time visit.

Knowing the history of the more conventional-looking business letter-writing lesson is also essential for understanding the teacher's instructional objectives and the students' learning opportunities. Were the students' letters actually going to be sent anywhere? In most classes, the answer would be no. In Ms. Jefferson's class, the answer was yes. Had the students asked for help with letter writing? In most classes, the answer would be no. In Ms. Jefferson's class, the answer was yes. Yet, she, like her traditional counterparts, did not seek student views on what constitutes an acceptable form for a business letter. She shared the standard model considered acceptable in the business culture. In many classrooms, the teacher determines when the letter writing lesson will occur and uses letter-writing worksheets to teach the traditional forms. In Ms. Jefferson's class, the particular students with her in the small group had asked her for help in making their "real" letters "right." They were asking local business people to allow them to come for tours and interviews to better understand the term "profit," a concept they were finding quite elusive in their math class. Ms. Jefferson knew the students would be engaged in much analytical thinking, decision making, and open-ended inquiry as they generated their questions and tried to make

sense of the answers they received. But the standard form of a business letter was not an example of such open-ended inquiry. To appreciate the totality of the letter-writing lesson in Ms. Jefferson's class, one must understand the constructivist context in which this "traditionally structured" learning episode was situated.

Invisible Structures

Now let's consider Ms. Addams's 2nd grade classroom, where students sat in rows facing the chalkboard, working diligently with paper and pencil on an arithmetic problem. A visual glance in the room would suggest a traditional classroom. But let's look at the assignment the children were working on. Ms. Addams asked her students to configure the table arrangement for the Parent Book Club meeting scheduled for later in the day. "There will be 57 parents attending," Ms. Addams told the class. "Each table can seat up to six parents. How many tables will we need to set up for the meeting?"

Over the next 45 minutes, the students generated multiple interpretations of the problem and multiple pathways to their solutions. Because 6 is not a factor of 57, Ms. Addams was particularly interested to see how the students would deal with the remainder. By considering students' differential responses, she would be able to determine which students' understandings of the part/whole relationship would make future instruction with more sophisticated division problems appropriate, and which students might benefit from further problems in part/whole/remainder relationships.

The illustrations of Ms. Jefferson's and Ms. Addams's classrooms show the variability in the physical classroom structures that are compatible with constructivist pedagogy. Constructivist learning theory does not dictate one specific classroom configuration. There is far less student movement about the room in Ms. Addams's class than in Ms. Jefferson's class. Seating arrangements and classroom procedures are different. Yet both Ms. Jefferson and Ms. Addams see conceptual change as the key to cognitive growth and development. The teaching structures they put into place in their classrooms to

foster concept formation remain largely invisible through a glance into the room.

Identifying conceptual change is an essential quest for each teacher's professional action. The precise nature of that action rests in each teacher's negotiations with the learners. As Postman (1996) states, "While it is possible to speak wisely about education, it is impossible to speak definitively" (p. 139). It is the intellectual responsibility of Ms. Jefferson and Ms. Addams to make ongoing decisions unique to the moment and context. If we can't trust them to do that well, we will continue to create policies and requirements that drive the very best Ms. Jeffersons and Ms. Addamses out of education.

Efficiency in Learning

Very often, teachers resonate to the principles of constructivist learning theory and agree with its many interpretations in classroom practice, but question its efficiency in terms of the amount of time devoted to the exploration of a single concept. A typical protest might be, "I could never spend three weeks on the circumference of a circle." Efficiency is a complex paradoxical issue in education. We aim to provide learning opportunities for students to become efficient learners, but we do not necessarily aim for efficient teaching.

As we've discussed, teachers with sophisticated understandings of learning processes often begin lessons by inviting students to tackle a purposefully ambiguous problem that the students recast in ways that will make sense to them. By observing students' varied analyses and approaches, teachers can diagnose the variables that students deem salient, the pre-existing skills students bring to the tasks, and the opportunities for leading-edge teaching. With a teacher who devotes three weeks to the study of circumference, some students may begin their study of the concept by investigating the perimeters of polygons with string, and then do the same for circles of many sizes. Other students may chart patterns emerging from measuring the perimeters of polygons with increasing numbers of sides. Still others may begin by applying the formula for computing circumference, $C=2\pi r$, to a number of cases.

As class time progresses, and as the teacher orchestrates the students' sharing of their investigations, the teacher invites elaboration of ideas and highlights conflicting conclusions for fuller study by the whole group. As students revisit circumference and circle concepts in their inquiries with other polygons and in their inquiries with other attributes of polygons, they transform their knowledge to either include increasing information or accommodate increasingly more efficient strategies. For instance, students may begin to see patterns as they compute areas of regular hexagons, then octagons, then decagons, then dodecagons. If their patterns suggest to them that the areas of polygons with increasing numbers of sides approaches the area of a circle, they may be ready for a peek into the study of calculus, if not a more extensive exploration.

As this example suggests, it is not easy to compute the efficiency of teaching practices by dividing what students learn by the time they take to learn it. Not only is it difficult to quantify what comprises a lesson, the measurement of what is learned is also amorphous. Do we count the many tangential concepts that arise in any one lesson by recording them in a log the first time they come up and then keeping a running tally? At any one moment in time, what is learned is nonquantifiable as a function of that moment. Students spiral through many struggles during investigations that they design themselves. The universe of human intelligence is a marvelous web of interrelated issues that becomes more complex as our study of each issue continues. As Einstein pointed out in his famous quote, "As the circle of light increases, so does the circumference of darkness around it."

There are many factors that emerge as critical for educators to consider when deciding professional practice, but for the constructivist educator, efficient teaching isn't one of them. However, a teacher's sensitivity to a student's search for efficiency is! A student's search for efficient structures and processes teaches the teacher much about the child's thinking. Is the child chunking items or information in the context of a larger categorization task? Is the child condensing groups for ease of problem solving? Fosnot (1996) reports on the processes by which students search for efficient structures as they

develop algorithms. Forman and Hill (1980) report on preschoolers' changes in thinking as they move from building a three-block bridge, with two blocks supporting the third block, to a two-block arch, with each block simultaneously supporting the other. These examples illustrate the constructivist educator's role in prompting students to develop and modify their own strategies as they sort through problems. The educator does not presort strategies for the student.

Collective Leadership

A few years ago, three colleagues and I found ourselves reminiscing about our early teaching days in a public school district noted for its innovation, leadership, and vision. Financial issues and shifting community ideals have long since changed that district's tenor and commitments, and job changes have brought each of us to different settings. Still, we agreed that the culture we experienced in that system during our years there did much to shape us as professionals.

Unlike my colleagues, I began in the district as a student teacher. From the outset I was afforded enormous autonomy. I had my own 6th grade math groups and reading groups, negotiated learning contracts with students, designed three-week-long special projects, and formulated community service plans with students, organizing parents to help. I had to make decisions at every turn, and I made assumptions about the characteristics of a typical teaching job based on what I saw and heard and on what I was asked to do. It didn't take long for me to establish my viewpoint.

My colleagues agreed that being hired into the positive professional culture we experienced during our earlier teaching days forged a lasting pledge to the profession. That culture helped instill in us a permanent sense of urgency to always do a better job. After a good deal of thought and discussion, we identified the following practices and attitudes that existed within that school district as being the most important in

shaping its culture—and the most influential in shaping us as educators:

- *The district leadership offered us a palette of pedagogically focused options for professional development, each including comprehensive follow-up and feedback.* The quality of in-service activities was cutting edge; the change agents who led our efforts were leaders in their fields. Under their guidance, our district's teachers were thrown into cognitive disequilibria, a state that, if we didn't exactly welcome, we at least tolerated long enough to achieve some temporary resolution. We knew our administrators valued growth, and we knew they understood disequilibria as a necessary stage of growth. The district was committed to staff development, not pep rallies with slogans and pom-poms.

- *We were members of various professional learning communities in which collaboration and consistent growth were the cultural norm.* The district leadership, the building-level leadership, and the teacher leadership established this norm. These professional learning communities, made up mostly of teachers throughout the district, upped the ante. They encouraged freedom and respect and forged a collective leadership team.

- *"Why is this important?" became a question we constantly asked each other.* Many of our administrators were our educational leaders. They gave us the freedom to examine new programs, materials, and teaching approaches. We decided what to try based on our readings or the courses we were taking, and then we were asked to analyze our findings and make adjustments. Our administrators had clear expectations that, as teachers, we were to make performance decisions. The expectations didn't stop there. "That's great. When are you going to write about it?" was often the next challenge. Sometimes, we answered with, "I just climbed a mountain. Can I just pitch a tent for a few days?"

- *Material selection was the teacher's prerogative.* Teachers had a budget allocation and chose materials autonomously. Administrators and teachers rejected the tradition of single-source texts, finding it a model that failed to capture the reality of how important learning takes place. We wanted our

students to seek multiple perspectives and to replicate findings. The essential concepts to teach were defined by district curriculum guidelines and state requirements, but finding, designing, and adapting teaching materials to fit the cognitive needs of the students was left to the teacher.

• *We set new expectations for ourselves . . . and found we couldn't go back.* At some point, our teaching priorities became different. School wasn't about teachers in charge of learning. It was about learners in charge of learning. Once we saw our students as intellectual beings on a search for understanding, we treated them more respectfully, created new curriculum options for them, found they treated us more respectfully, and ultimately reported a heightened intellectual and humanitarian level for all in the class.

Dreams and Disobedience

Martin Luther King is a special hero of mine. Still, the civil rights activists who strike a deeper chord are the anonymous women who boycotted city buses in Montgomery, Alabama, choosing to walk three hours to their housecleaning jobs every morning and walk three hours back home at the end of their workday. As adults, these women of color were told they could not sit in the front of the bus; as children, they were told they could not attend certain schools. I don't know the names of many of these women, and their individual stories are not known to most. But they were here and they made a difference.

They remind me of other women of the same generation whose names I do know. The skin color of the five sisters in this photograph did not prevent them from attending certain schools as children. But as their mother brought each of them to the local public school to register, they were told their names were not "American enough." So the school changed their names. Elana, Perrina, Margarita, Lucia, and Adelina became Helen, Perry, Margaret, Lucy, and Adele.



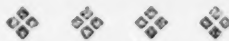
These events happened many years ago. Sadly, we seem to have no shortage of present-day stories today to replace them. I always ask myself: If I were a citizen denied equal access to services, could I have sacrificed what those many women who walked past the bus stop and all the way to work sacrificed? If I were a young mother who didn't speak much English, could I have found the courage to say "no" to the school officials and insist that my children keep their given names? I'm not sure. But I know one thing: I, like everyone, have a dream. I dream of a time when schools everywhere will always make room for children the way they are, the way they come, and with the names they have. I dream of a time when all children will go to school to *create* more often than they will go to school to *comply* . . . when they will go to school to *find out* more often than to *follow*.

In the process of creating something new—whether it be a story, a play, a painting, an equation, a theory, a game, music,

or any new knowledge—learners of all ages encounter rules, laws, and constraints. These rules are largely determined by convention, by laws apparently dictated by external forces, and by constraints imposed by people or materials.

Schools must focus on helping learners create new knowledge by helping them cope effectively with these rules, laws, constraints, and present realities and by helping them discern when and how and in what manner defying those rules, laws, constraints, and realities might be appropriate. The alternative is schools that focus on ensuring students' compliance with the rules, the laws, the constraints, and the present realities. These schools jeopardize their students' chances to create new knowledge and new understandings. Schools that demand that students follow (rather than engage in the finding out process that is often perceived as inefficient) rarely teach students to find out. Conversely, schools that demand rigor in students' finding out, rather than following, teach students how to find out and also how to follow.

Living a life with standards . . . living a life with questions . . . living a life in search of meaning. These are not quests. These are present realities. Schools are for learners already living a life, not preparing to live a life. The lives they are presently living must be honored. And we can't do that unless we look beyond common thinking, bring real life back to school life, and in doing so, reclaim the essence of learning.



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Online Resources

An Overview of Constructivism

Developed by Martin Ryder, of the University of Colorado at Denver School of Education, this site offers definitions, readings, corollary websites, and many links to related theories.
http://carbon.cudenver.edu/~mryder/itc_data/constructivism.html

Constructivism and the Five E's

Developed by the Miami Museum of Science, this site describes a framework developed by Roger Bybee and his colleagues on the Biological Science Curriculum Study (BSCS) team. The instructional model includes engage, explore, elaborate, evaluate, and navigate. The site links to models for classroom use.
<http://www.miamisci.org/ph/lpintro5e.html>

Constructivism: From Philosophy to Practice

Developed by Elizabeth Murphy of the Université Laval, Quebec City, Quebec, Canada, this site opens by describing Socrates and his connection with constructivism. It links to a bibliography and classroom connections.
<http://www.stemnet.nf.ca/~elmurphy/emurphy/cle.html>

Constructivism in Elementary Education

Maintained by the Educational Research Information Clearinghouse (ERIC) on Reading, English, and Communication at Indiana University, this site lists ERIC documents on constructivism in elementary education. Some of the articles are applicable across the grade levels.
http://www.indiana.edu/%7Eeric_rec/ieo/bibs/cons-ele.html

Essays on Constructivism and Education

Developed by Tom O'Haver at the Maryland Collaborative for Teacher Preparation, this site provides a list of highly relevant, diverse, and accessible articles.

<http://www.towson.edu/csme/mctp/Essays.html>

UMASS Physics Education Research Group

Developed by the University of Massachusetts at Amherst, this site opens with a background piece on constructivism in science education, then links to other university-based physics education research groups, as well as general education sites. It also has links to publications, other research, and outreach.

<http://www.perg.phast.umass.edu/perspective/Constructivism.html>

Epistemological Constructivism

Developed by Francis Heylighen, this site describes epistemology, cybernetics, and systems theory with links to important thinkers in the fields, social constructivism, physical constructivism, and a discussion forum.

<http://pespmc1.vub.ac.be/CONSTRUC.html>

Radical Constructivism

Developed by Alex Riegler, this site links to a discussion of constructivism's philosophical roots as well as a wide range of conferences, related articles, examples of specific school-based programs, controversial issues, and a discussion forum.

<http://www.univie.ac.at/constructivism/>

Reggio Emilia Early Childhood

Developed through collaboration among the early childhood educators and other members of the Cyert Center Team, this site describes the Reggio Emilia approach to early childhood education: a city-run and sponsored system designed for all children from birth through age six. The site describes the principles on which the project is based and links to other valuable resources.

<http://www.cmu.edu/cyert-center/reggio.htm>

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Related ASCD Resources: Constructivism

Audiotapes

Constructivist and Brain-Based Teaching, by Perry Rettig (#299164)

On Constructivism, by Jacqueline Grennon Brooks (#296030)

Supervision of the Constructivist Classroom, by Charles Connor,
Francine Deal, and Betty Klear (#299065)

Multimedia

Constructivism Professional Inquiry Kit (#997149)

Networks

Visit the ASCD Web site (www.ascd.org) and click on About ASCD. Under the header of Your Partnership with ASCD, click on Networks for information about professional educators who have formed groups around topics such as "Building Intrinsically Motivating Learning Environments," "Invitational Education," and "Teaching Thinking." Look in the Network Directory for current facilitators' addresses and phone numbers.

Online Tutorial

Professional development available on the ASCD Web site:

Constructivism (<http://www.ascd.org/frameutorials.html>)

Print Products

Education Update (May 2001): "Accountability, Testing, and Constructivist Teaching" (#101022)

In Search of Understanding: The Case for Constructivist Classrooms
(revised edition) by Jacqueline Grennon Brooks and Martin Brooks
(#199234)

Videotapes

Constructivism (2-tape series with facilitator's guide) (#495233)

Constructivism Series Tape 1: Putting the Learner First (#495234)

Constructivism Series Tape 2: Case Studies in Constructivist Teaching
(#495235)

A Parent's Guide to Constructivism (part of the *What's New In School II*
videotape series) (#496223)

For additional information, visit us on the World Wide Web (<http://www.ascd.org>), send an e-mail message to member@ascd.org, call the ASCD Service Center (1-800-933-ASCD or 703-578-9600, then press 2), send a fax to 703-575-5400, or write to Information Services, ASCD, 1703 N. Beauregard St., Alexandria, VA 22311-1714 USA.

Schooling for Life

Too many students experience school as a place to put in time — and view their lives within school walls as distinctly different from their lives at home and in their community. Too many educators seem to share that point of view and focus more on lists of standards than the students they are supposed to serve. This book is about how we might blur the distinctions between "school life" and "real life," between learning and teaching, between learning well and living well. It's for anyone who has ever asked

- ❖ When did we decide test scores were more important than understanding?
- ❖ When did we accept the image of teachers as mere implementers of state curricula?
- ❖ When did we accept the idea that schools are places where no one has to think too hard?

This book is a rallying cry to our true educational mission. It's an assertion that we can have the schools we really want if we're bold enough to look beyond the old myths of what a good school is, and instead, work to facilitate intellectual, ethical, and aesthetic growth in our students and ourselves. Author **Jacqueline Grennon Brooks** goes inside the classroom to share the experiences of teachers, parents, and students and present contrasting examples of schooling that honors the complexity of learning and life and schooling that ignores it. It's a journey that will inspire us all to reexamine practices and revitalize schools.

RECLAIMING THE ESSENCE OF LEARNING

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